The Development and Empirical Testing of a Pressure/ Response Model of Green Supply Chain Management amongst a cross-sectoral sample of members of The Chartered Institute of Purchasing and Supply

Volume I

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ABSTRACT

This study develops and empirically tests a model of factors determining green supply chain management practices in organisations. Previous research on aspects of green supply chain management is dominated by anecdotal, sector specific studies that examine specific aspects of the supply chain, such as purchasing or logistics. Many argue this field is embryonic and lacking a structured integrative framework of research. This study addresses this gap by focussing on a whole supply chain approach that provides a synthesis of previous research to develop a model of green supply chain management. The data from a cross-sectoral survey of 149 members the Chartered Institute of Purchasing and Supply is used to test this model, using a variety of multivariate techniques.

The model identifies environmental attitude as the primary determinant of green supply chain management practices, influenced to a lesser extent by external legislative factors. The influence of organisational contingencies on this model is also explored, and size identified as the only contingency that influences the relationships in this model. The dominant influence of environmental attitude suggests that within organisations there are internal factors, or individuals, that may push forward the green agenda, and those initiatives that focus on changing the environmental attitude/ culture of an organisation might be the most effective at improving environmental performance.

This study suggests that factors previously identified as important within green supply chain management, such as supply chain or competitive pressures, are less influential than expected. However, future research should seek to compare the findings from this study with a larger, cross-sectoral sample that includes diverse organisations from different nations, sectors and levels of channel power.

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GLOSSARY

3DCE	three-dimensional concurrent engineering
ACBE	Advisory Committee for Business and the Environment
B2B	Business-to-Business
B2C	Business-to-Consumers
BiC	Business in the Community
BiE	Business in the Environment
BSREF	Business for Social Responsibility Education Fund
CBI	Confederation of British Industry
CEC	Commission of the European Communities
CEST	Centre for Exploitation of Science and Technology
CIPS	The Chartered Institute of Purchasing and Supply
CLM	Council of Logistics Managers (USA)
CSR	Corporate Social Responsibility
DETR	Department of Environment, Transport and the Regions
DoE	Department of the Environment
DTI	Department of Trade and Industry
EA	The Environment Agency
ECB	environmentally conscious behaviour
ECSM	environmental conscious supply chain management
ESCM	environmental supply chain management
EEO	Energy Efficiency Office
EMS	Environmental Management System
ENDS	Environmental Data Services
EPA	Environmental Protection Agency (USA)
ETBP	Environmental Technology Best Practice Programme
ETI	Ethical Trading Initiative
gscm	green supply chain management
ICC	International Chamber of Commerce
IHEI	International Hotels Environmental Initiative
IM	Institute of Managers
IoD	Institute of Directors

ISM	Institute for Supply Management (USA)
LCA	Life cycle assessment
NAPM	National Association of Purchasing Managers (USA)
NGO	Non Governmental Organisation
PCA	Principal components analysis
SIC	Standard Industrial Classification
TRI	Toxic Release Inventory (EPA)
TQM	Total Quality Management
WBCSD	World Business Council for Sustainable Development

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Dedicated to Helen Robertson

CHAPTER 1: INTRODUCTION

1.1 Introduction

The overall aim of this research is to propose, and test, a generic model of the external and internal drivers and management practices associated with green supply chain management, amongst a cross-sectoral sample of UK based organisations. The management practices examined in this research incorporate practices associated with green purchasing (including supplier management), internal environmental operations management and green logistics (including reverse logistics). The influences of organisational contingencies (such as sector) are examined to see if they significantly affect the relationships in this generic model, and the specific type and level of these management practices. This is achieved by synthesising previous research on aspects of green supply chain management, to develop a generic pressure/response model and examining this model using data collected via a survey based research instrument. Before detailing the specific objectives of this study a brief introduction to green supply chain management is presented, followed by a detailed critique of current literature in this field.

This chapter:

- presents an introduction to green supply chain management (section 1.2);
- identifies the general criticisms of previous green supply chain management research and explores the specific research gaps, which are addressed in this study (section 1.3);
- presents the research objectives of the thesis (section 1.4);
- examines the development of the inductive pressure/response model of green supply chain management (section 1.5);
- identifies the research methodology (section 1.6); and
- presents a detailed overview of the thesis structure (section 1.7).

1.2 Supply Chain Management and the Environment

Tan (2001) presents a review of the development of literature in the supply chain management field, discussing the emergence of supply chain management as a holistic and strategic approach, developed from the unification of work in the transportation/logistics field and purchasing field. Tan (2001:39) further states that supply chain management is a commonly accepted terminology that includes all the value creating activities along the supply chain. A review of the wider supply chain management literature is not presented in this study and readers are directed towards authors such as Croom 2000; Harland 1996; New 1997; Tan 2001; Svensson 2003; and Waller 1999.

The supply chain is the integrated process operations network in place to provide tangible goods or services to a client (Waller 1999). Environmental issues potentially impact every aspect of the supply chain from plant location, raw materials purchase, product design, technologies employed, manufacturing processes, packaging, transportation, energy consumption, worker safety, marketing, sales and final product disposal (Waller 1999; Wu and Dunn 1995). Bowen *et al.* (2001b) identifies two types of green supply. The first, defined as '*greening the supply process*', represents process-based adaptations made to the firm's supplier management activities in order to incorporate environmental considerations (these include the process of collecting environmental information on suppliers and assessing and ranking suppliers' environmental performance). The second type of activity is what they term *'product-based green supply'*. This involves changes in the product supplied (including attempts to manage the by-products of supplied inputs such as packaging and co-operation with suppliers). This study examines both product based and process based management practices that organisations may undertake to improve their own, or their suppliers', environmental performance. Green supply chain management practices could include demonstrating a strategic commitment to the environment, supplier initiatives for environmental improvement, designing products that can be disassembled, reused or recycled, adopting a life cycle approach to the design of products, critically reviewing and reassessing existing products, processes and services (van Hoek 1999). Although product-based green supply is arguably traditionally associated with manufacturing organisations, Welford *et al.* (1998) notes the necessity to also examine environmental behaviour in service industries. Such sectors, like the public or banking sectors, are under increasing pressure to improve their environmental performance, especially through their supply chains (New *et al.* 1998, 2002; Russel 1998). Such practices include supplier management, greener purchasing and managing waste products. Therefore, the distinction made between product-based and process-based green supply chain management is equally applicable to organisations in every sector (although specific products and specific processes will obviously differ depending on the type of goods and services provided by each individual organisation).

Over the last decade increasing attention has focused on gaining value from supply chains, moving beyond the traditional 'boundaries' of an organisation and including aspects such as manufacturing organisations offering reconditioning services (Wise and Baumgartner 1999). This upstream (supplier focused) and downstream (customer focused) movement into the supply chain has also extended to the management of environmental issues and the environmental risks associated with an organisation's goods and services (as illustrated in the cases presented in appendix 3).

Clift and Wright (2000:281) state that:

> *'it has become accepted as a matter of policy that environmental management requires the consideration of the whole of the supply chain of materials and energy required to make a product or, more generally, to deliver a service or benefit'.*

The 'greening' of the supply chain is identified as one of the future challenges facing organisations by Handfield and Nicholls (1999) who state that *'in the future organisations will have to make all supply chain decisions within the context of environmental concerns'* (p.159).

Gascoigne (2002:62) further states:

'that green supply chain management is this year's 'in thing'. Blue Chip companies who have improved their in-house environmental performance through ISO14001and EMAS have turned their attention to their suppliers and subcontractors. Even those without formal environmental management systems have started to think about managing the environmental risks posed by their supply chain'.

These comments by Gascoigne (2002) appear to be supported by quotes from representatives at Phillips, Xerox, and Hewlett Packard as detailed below, which all suggest the importance of sustainability and green initiatives in the supply chain.

> *'As differentiation between products in saturated markets becomes even harder to find companies search for added value in other aspects of production and operations. The environment adds a market edge, can add a premium to some products or introduce a feel good factor to customers and their business. It greatly benefits a company's efforts to be a good corporate citizen and to behave responsibly to its stakeholders'* (Phillips cited in McIntyre *et al.* 1998:150).

> *'Individual organisations are facing a change in the required attitude to environmental aspects and impacts. Any company is part of a supply chain, communicating with its suppliers and clients and subject to continuously developing legislation. The suppliers' responsibilities to society (the client) are consequently extending from a need for technical performance and reliability to care for the environment and attention to occupational health and safety'* (Xerox cited in Meinders and Meuffels 2001: 348).

> *'Sustainability has become a strategic imperative for all businesses in the 21st Century. It has become a fundamental market force affecting long-term financial viability and success. Customers are requiring sustainable business practices'* (Hewlett Packard cited in Preston 2001:26).

However, it is not just 'Blue Chip' companies that are affected by the 'greening of the supply chain'. As Sarkis (2001:21) notes:

> *'every organisation is a member of a supply chain or network. The decisions made by any organisation will have numerous implications up and down the supply chain, with environmental implications also diffusing through the supply chain'.*

Thus, arguably the implication of this statement is that any integration of environmental issues into supply chain management could potentially have implications for every organisation and every sector, to a greater or lesser extent. Whilst it might be argued that environmental issues are not affecting *all* types of organisations equally[1], it is undeniable that the last 30 years has seen increasing environmental restrictions and the introduction of a variety of operational environmental initiatives in many of the larger, 'dirtier' industries (as summarised in appendix 2).

Yet, as Sarkis (2001: 22) states,

> *'academic research in green supply chain management is relatively young as we try to make sense of what works, what does not work and how to improve the greening of the supply chain through various tools and advances'.*

Croom *et al.* (2000) and Tan (2001), all note the embryonic nature of research into *supply chain* management. Angell and Klassen (1996), Carter and Ellram (1998), Carter *et al.* (1998), Murphy *et al.* (1994) and Cramer (1999) make the same criticism about aspects of green supply chain management. If the research into supply chain management is classed as embryonic, then this is arguably equally true of research in the green supply chain management field. Therefore, there is a need to synthesise current research on aspects of green supply chain management, and identify the controls over this process.

Previous research into aspects of 'green supply chain management' consists of a series of sub-areas of research, as defined in Figure 1.1. Appendix 2 discusses the development of environmentalism in business and this has traditionally focused upon *internal* environmental management practices. The movement of environmental issues into the supply chain as noted in the discussion presented so far, extends environmental operational practices from just those associated with internal environmental operations management into operational practices associated with green purchasing, supplier management and green logistics (including reverse logistics). Linnanen and Halme (1996: 67) state that

'only by widening the environmental perspective from products to

[1] This is examined in this study by exploring the influence of organisational contingencies (represented by the demographic characteristics), within the findings in chapters 7-10

systems, into business systems and strategies, the production process and beyond the boundaries of the firm, can industry try to become sustainable'.

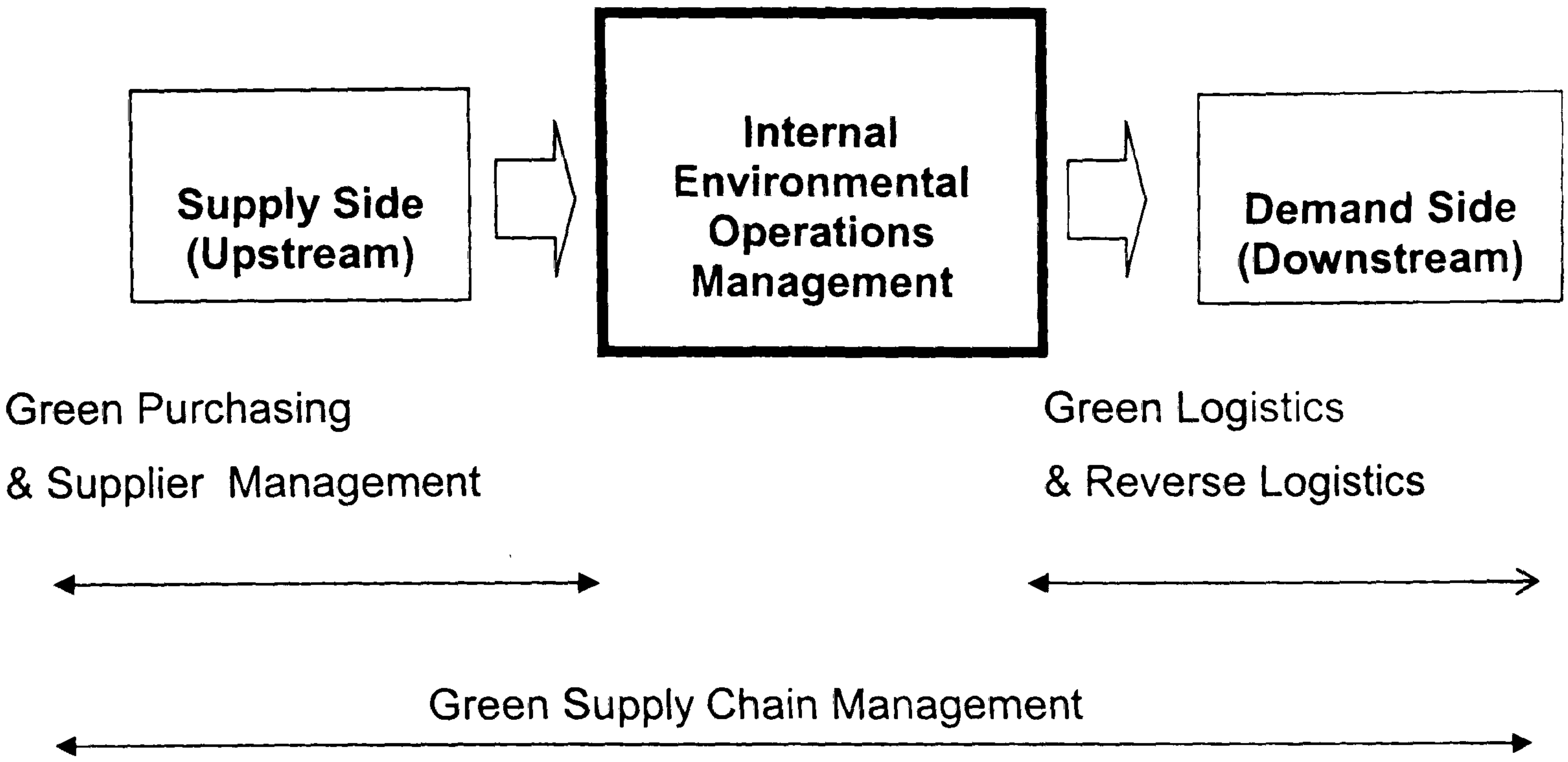

Figure 1.1: The areas of literature associated with greening the supply chain

Many of the previous research studies of aspects of green supply chain management specifically focus on green purchasing **or** green logistics (as illustrated in appendix 1), rather than the totality of the green supply chain to examine both upstream and downstream activities (as recommended by authors such as Wu and Dunn 1995). In order to examine both upstream and downstream activities in a green supply chain it is necessary to define each of these aspects of green supply chain management as illustrated in figure 1.1, as presented below.

Russel (1998:9) defines **green purchasing** as the *'integration of environmental considerations into purchasing policies, programme and actions'.* Whilst, Carter and Carter (1998:660) define environmental purchasing as the purchasing function's involvement in supply chain management activities in order to facilitate recycling, reuse and resource reduction. Yet, they also state that:

'purchasing's role can go far beyond merely recycling and reuse by auditing the supply chain for life cycle costs, design for disassembly and

> *reuse opportunities and supplier technology development programmes (p.660)'.*

The role of purchasing is intertwined with logistics as all suppliers are also someone else's customer (Hill 1997). In fact purchasing plays a key role in a firm's logistics operations (Lambert and Stock 1993) as the purchasing function sits at an organisation's boundary and acts as one of the key interfaces between a firm's internal logistics system and the upstream supply chain (Carter and Jennings 2001).

Jolly and Charter (1992) review the development of **green logistics** arguing that logistics has a highly visible role from an environmental perspective and they identify four main areas where environmental issues could be a key challenge: transport management; materials handling; warehousing; and management of human resources. **Reverse logistics** is a part of the logistics function but is specifically focussed on reverse distribution. It is the process by which a company collects it's used, damaged, outdated products or packaging from the end user (after Kopicki *et al.* 1993). Reverse logistics is a key element of product take back schemes and re-manufacturing programmes, where products/materials are returned to the original manufacturer or agent for reuse, recycling or re-manufacture. However, reverse logistics is also applicable in non-manufacturing industries where it refers to the return of products such as electronic equipment, photocopiers, toner cartridges and packaging systems like pallets back to an original supplier. Thus, reverse logistics describes the process by which these products or materials arrive back at the reuse, re-manufacturing or recycling facility.

Environmental operations management is defined by Gupta and Sharma (1996) as the integration of environmental management principles with the decision-making process for the conversion of resources into viable products and services. Appendix 2 details some of the internal environmental operational management tools and techniques used in organisations, such as environmental management systems and resource efficiency programmes.

A more comprehensive definition of **green supply chain management** emerges from the integration of green purchasing, internal environmental operations management and green logistics theory. Wu and Dunn (1995) argue that in order to minimise the total environmental impact of business, it must be evaluated from a total system perspective as represented by the supply chain. Authors such as Beamon (1999), Linnanen and Halme (1996), van Hoek (1999), and Wu and Dunn (1995) all stress the need to take a systematic, holistic view of the supply chain to effect environmental improvement.

Hutchinson (1998) also notes the need for a focus on the whole of the supply chain as a result of the emergence of life-cycle thinking. He suggests that environmental concerns extend beyond an organisation's own boundaries and that improvements in environmental performance can be achieved through the supply chain, thus creating value for the business. However, Hutchinson also notes that the value-adding argument may break down when there are differing perceptions between customer and supplier of the value to be gained, or when several intermediaries distance the supplier from final users[2]. Rondinelli and Berry (1998) note that cutting-edge corporations analyse strategically, and link more effectively, every segment of their value chains. Leaders in value-chain management are also integrating their environmental management practices into their relationships with their suppliers and customers. This approach to green supply chain management as taken by leading edge companies is noted by the BSREF[3] study of leading US organisations (in Gavaghan *et al.* 1998; Lippmann 1999, 2001).

The approach detailed above of linking environmental management to activities with suppliers is defined by Linnanen and Halme (1996) as '**upstream steering**', using vendor management and supplier selection as part of green purchasing. The key organisations in a supply chain might take

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2 The influence of 'power' and specifically customer and supplier dependency is examined within this study in recognition of these comments by Hutchinson (1998), using the organisational contingencies in the statistical analysis in chapters 7-10.

3 See Glossary for details of abbreviated references.

the most 'powerful' position in the role of 'chain designer'; a philosophy that is defined as 'beginning-of-the-pipe' (after Linnanen *et al.* 1995) or 'ecology-pull' (after Meffert and Kirchgeorg 1993; Halme 1995).

The idea of 'environmental value-chain management' as discussed by Linnanen and Halme (1996) draws upon the concept of industrial ecology and material flow management. In an environmental value chain the traditional linear addition of value during processing and the negative or low value after consumption is converted into a circular value chain or closed cycle aimed at minimising material inputs, sustaining desired performance and reducing waste outputs. The **environmental value** chain approach stresses explicitly the use of a circular and closed materials cycle. This is perhaps the ultimate aim of green supply chain management, but in most examples used in this study and the literature, green supply chain management aims to reduce materials consumption and facilitate materials recycling, but does not explicitly expect the more advanced status of materials cycling, in a closed system.

'**Downstream steering**' (after Linnanen and Halme 1996) is driven by the responsibility a firm has for the entire life cycle of its products. Often this is referred to as 'product stewardship' which Meffert and Kirchgeorg (1993) also defined as 'ecology-push', with the responsibility of materials management by the producer leading to 'closed loop' ecodesign, design for disassembly and reverse logistics.

Young and Kielkiewicz-Young (2001) also discuss '**sustainable supply networks**', which is a wider approach than even green supply chain management, as it examines social issues such as labour conditions, rather than just environmental issues. In a sustainable supply network, environmental criteria are used *along with* other social criteria. Suppliers must fulfil these environmental criteria to be classed as preferred suppliers and accreditation to an environmental management standard is used as a benchmark to assess environmental performance. The strategies in use as identified by Young and Kielkiewicz-Young (2001) include: communicating sustainable policies and goals; sustainable purchasing policies; prequalification criteria (such as accreditation to a environmental management standard), sustainable/ environmental performance criteria; purchasing specifications; contractual obligations; supplier/ customer partnerships and alliances; sustainable green purchasing training; incentive programmes; sustainability programmes with suppliers; environmental assessments of suppliers; internal training and evaluation; use of cross-functional teams; and working with peers in partnership programmes for best practice knowledge sharing[4].

Green supply chain management is defined by Sarkis (2001:21) as *'the operationalisation of many of the topics within industrial ecosystems and industrial ecology'* and that managing the supply chain is intertwined with many environmental programmes in organisations.

In this study the '**green supply chain management'** uses the definitions presented above to investigate the integration of environmental issues across an organisation's supply chain. This incorporates:

- internal environmental management practices associated with internal process and product improvements;
- development of green policy to incorporate environmental issues into the strategic management of an organisation;
- the greening of the purchasing function;
- the use of vendor management tools and techniques to check the performance of suppliers; and
- greening of the logistics function.

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4 This study explicitly focuses on environmental (i.e. ecological) management for which the term 'green' is typically used. It does not examine the broader CSR debate which includes social issues. However, many of the guidelines established by Young and Kielkiewicz-Young (2001) are incorporated into the research instrument but from an environmental/green perspective only.

This study focuses on ecological issues, rather than social issues, and only specifically examines first-tier supply chain relationships, although some data is collected on suppliers/ customers beyond the first tier.

Thus, the focus of this study is on **the integration of upstream activities such as green purchasing and supplier management, with internal environmental operational practices, and downstream activities associated with green logistics to improve the environmental performance of individual organisations and those directly linked to them in a supply chain.**

1.3 General Criticisms of Previous Green Supply Chain Management Research

Appendix 1.1 provides an overview of the key literature into aspects of green supply chain management that forms the basis of chapter 2 and the literature critique presented in this section. This appendix presents a summary of each study, key contributions, main research gaps/recommendations for further research and a brief description of the methodology used. A further analysis of this literature is also presented in table 1.1

Table 1.1 indicates that the majority of the influential prior research studies on aspects of green supply suffer from one or more of the following limitations:

- embryonic nature;
- the use of descriptive and anecdotal research;
- lack of focus on the whole of the supply chain; or
- geographical or sectoral bias.

Table 1.1 also identifies the focus of these previous studies and whether they examine any of the specific aspects of the green supply chain model developed in chapter 3, and summarised in section 1.5

Table 1.1: Summary of selected influential prior studies

KEY	Type Study	Main Focus	Organisational contingencies examined	Additional comments
	S – survey IV- interview TB- Theory Building[5] C(n)-Case (number)	L – Downstream P – Upstream SB – Supplier-Buyer relationships O-Other	I^{2} - industry type & number groups n – nationality/geographical location a - environmental attitude s - organisational size r – level of risk ei – level of impact cs -cross sectional le- leading edge/proactive sample	*- uses same research instrument as other references (*) with additional new data collected X – refers to the presence of survey questionnaires or theory building in this general area

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Anderson *et al.* 1999	IV C(5)	UK		L										X	
Autry *et al.* 2001	S	US	I^{5} s	L						X				X	
Banerjee et al. 2002	S	US	ei	O	X	X			X						
Barros *et al.* 1998	C	Netherlands		L						X					

[5] Includes literature reviews, development of research propositions and discussion papers using secondary data

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Baylis *et al* 1998b	S	UK	I^2 s	O	X	X									
Baylis et al 1998c	S	UK	I^2	O	X	X									
Baylis *et al.* 1998a	S	UK	I^4 s	P					X						X
Beamon 1999	TB	-		P L											X
Berger *et al.*, 2001	C TB	UK		O				X							X
Boons 2002	TB	-		P L					X						
Bowen *et al.* 2001a	S IV	UK	s I cs	P		X			X			X			X
Bowen *et al.* 2001b	S IV	UK	cs ei s	P		X			X			X	X		X
Cairncross 1992	TB	EU		L										X	
Canning and Hammer-Lloyd 1998	C (4) IV	UK		SB	X										X
Carter and Carter 1998	S *	US	I^2	P	X										X
Carter and Dresner 2001	IV	US		P	X		X								X
Carter and Ellram 1998	TB	-		L										X	
Carter and Jennings 2002	S	US		SB P								X			X
Carter and Jennings 2004	S	US	s	P	X	X									X
Carter *et al* 2000	S *	US	s	P											X
Carter *et al.* 1998	S (*)	US	n	P		X	X		X						X
Davis 1998	TB	US EU		L										X	
De Bakker *et al* 2002	C(2)	na	I^1	O		X			X						
Drumwright 1994	C IV (10)	US		P		X									X
Elliot *et al.* 1996	S	UK	s ei	O	X	X		X	X						

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Ellram *et al.* 2004	TB	-		L P SB				X	X	X		X	X	X	X
Elwood and Case 2001	TB	US		P											X
Ennarson 1998	IV	Sweden		P								X			
Faruk *et al.*, 2002	TB	UK		L P O											
Fleischmann *et al.* 2000	TB	-		L						X				X	
Florida 1996	S D	US Japan	s	O	X	X			X			X			
Gavaghan *et al.* 1998	IV	US	le	P	X				X			X			X
Geffen and Rothenberg 2000	IV	US	l[1]	SB		X								X	X
Green *et al.* 1996	C IV	UK		P SB								X			X
Green *et al.* 1998	C (1)	UK		P SB					X			X	X		X
Ghobadian *et al* 1998	S	UK	cs	O				X	X			X			
Gungor and Gupta 1999	TB	-		O					X	X				X	
Hagekaar *et al.* 2002	C (2)	na		O					X						
Hall 2000	C (4)	US Japan	l s	SB	X							X			
Hall 2001	C(5)	UK		P					X				X		
Halme 2002	C (1)	Finland		O		X			X						
Hart 1995	TB	-		O											
Hass 1996	C(1)	UK		SB					X						X
Henriques and Sadorsky 1996	S	Canada	s	O	X										
Henriques and Sadorsky 1999	S	Canada	s l cs	O	X	X									
Hill 1997	S IV	UK		P	X	X									X

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Holland and Gibbon 1997	S	UK	I^3	O	X				X						
Holt 1998	S	UK		O	X	X			X						
Jahre 1995	IV	Norway		L						X					
Jayaram *et al.* 1999	TB	US		L						X				X	
Johnson 1998	C (12)	US	I^1	L										X	X
Khoo *et al* 2001	TB	-		L						X					
Klassen and McLaughlin 1996	TB	-		O											
Klassen and Whybark 1999	S	US	I^1	O					X						
Klausner *et al.* 1998	TB	Germany		L										X	
Koipicki *et al.* 1993	TB	-		L						L				X	
Krikke *et al.* 1999	C (1)	Netherlands	I^1	L					X					X	
Kroon and Vrijens 1994	C TB	Netherlands		L										X	
Lamming and Hampson 1996	IV (5)	UK		P					X						X
Langerak *et al.* 1998	S	Netherlands	cs	O	X	X									X
Lippman, 1999	TB	US	le	P								X			X
Livingstone and Sparks 1994	S	UK Germany		O	X										
Lober 1996	TB	-		O				X	X	X	X	X	X		
Min and Gale 1997	S	US	I^{11}	P			X								X
Murphy and Poist 2000	S (*)	US EU	I^2 n a s	L		X			X	X	X	X			
Murphy and Poist 2003	S *	US EU	n	L		X		X	X	X	X	X			
Murphy *et al.* 1994	S	US	I^2 s	L					X	X				X	

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Murphy *et al.* 1995	S *	US	I^2 s	L	X		X	X	X	X	X	X			
Murphy *et al.* 1996	S *	US	I^2 a s	L	X	X	X	X	X	X	X	X			
Nagel 2003	C	US EU Asia Canadian		P								X			
Nagel and Meyer 1999	C TB	Germany		L										X	
New *et al.* 2002	IV TB	UK		P	X							X			X
New *et al.* 1999	C(1)	UK		P											X
Noci 1997	TB	-		P								X			
Pohlen and Faris 1992	IV	USA		L										X	
Polgreen 2002	TB	-		P	X							X			X
Polonsky *et al.* 1998	IV (11)	Austrailia	I^4	P											X
Prendergast and Pitt 1996	S	UK	I^5 s	O					X	X					
Preuss 2001	IV	UK	I^3 s	P	X		X					X			
Rao 2002	S	Asia	Ie cs	L P SB	X			X	X	X	X	X	X	X	X
Rodrique *et al.* 2001	TB	-		L						X					
Rogers 1995	TB	UK		L O					X					X	
Sarkis 1998	TB	-		O					X						
Sarkis and Rasheed 1995	TB	US EU Japan		O					X						
Sarkis *et al.* 1998	TB	-		L					X	X				X	
Stock *et al.* 1992	C TB	US		L										X	
Stray and Ballantine 2000	S	UK	I^6	O					X						

Reference	Type Study	Location	Demographic Characteristics	Main Focus	External Drivers	Internal Drivers	Obstacles	Environmental Policy	Internal Env Operations	Logistics	Industrial Networks	Supplier Assessment	Coaching and Education	Reverse Logistics	General Purchasing
Strong 1995	S	UK		SB P	X				X			X			
Theyel 2001	S IV	US		SB									X		
van Hoek 1999	TB	-		L P						X					X
Walton *et al.* 1998	C IV	US		P SB					X	X		X		X	X
Welford *et al.* 1998	TB	-		P L											
Wu and Dunn 1995	TB	-		L						X				X	
Young 2000	C	US		L										X	
Young and Kiekliewiez-Young 2001	S	US	I^5 s	PO											X
Ytterhus *et al.* 1999	C(1)	Norway		SB					X			X			
Zhu and Geng 2001	S	China	I^2	SB				X				X			
Zhuang and Synodinos 1997	S IV	UK	I^1	O	X										
Zsidisin and Hendrick 1998	S	US UK Germany	n cs	P					X	X		X		X	X
Zsidisin and Siferd 2001	TB	-		S								X		X	X

1.3.1 Embryonic nature of supply chain management research

A number of authors argue that research into the general area of supply chain management research is 'embryonic'. Croom *et al.* (2000:68) state that conceptually the management of supply chains is not particularly well understood, and 'embryonic' in nature. They, and other authors, highlight the necessity for clear definitional constructs and conceptual frameworks on supply chain management (Babbar and Prasad 1998; Cooper *et al.* 1997; New 1995; and Saunders 1995, 1998). Thus, if research in the wider area of supply chain management is classed as embryonic then that might arguably be applied to environmental/green supply chain management. In particular, Croom *et al.* (2000) identify the need for researchers to be aware of complimentary studies outside their own 'normal' domain of expertise. Arguably, one of these complimentary areas is that of environmental management, and particularly managing a supply chain for environmental/ecological purposes.

Walton *et al.* (1998:4) note a 'paucity' of research on issues concerning the role of suppliers in environmental management. Angell and Klassen (1996) also note the embryonic nature of research in the environmental operations arena. Zsidisin and Siferd (2001) also believe that progression towards theory development in environmental purchasing is still in its 'infancy'. Cramer (1998:163) claims that *'little research has so far been conducted into how companies put environmental management into practice and the internal and external forces that influence them'*. Faruk *et al.* (2002) believes that there is presently little theory to explain what occurs in supply chains and their management from an environmental perspective.

Bowen *et al* (2001a:42) perhaps best summarize the critical research gap between theory and practical implementation in green supply chain management stating:

> *'there appears to be a gap between the desirability of green supply chain activity in theory and the slow implementation of green supply at aggregate level across firms. Given this gap there is a research need to reorientate green supply chain research from theory to commercial*

practice'.

1.3.2 Descriptive and anecdotal nature of green supply chain management research

Traditionally environmental issues have not been high on the supply chain manager's agenda (Lamming and Hampson 1996), yet it can be argued that the supply chain is an increasing source of environmental pressure (Hill 1997). Carter and Carter (1998:661) state that supply chain management literature that examines environmental issues tends to be exploratory in nature. This comment is supported by Klassen and McLaughlin (1996:1200) who believe that much of the environmental management literature is prescriptive and anecdotal in nature, with few linkages to existing management literature. Handfield *et al.* (1997) state that the existing literature has only provided a broad framework for classifying organisational responses to green issues rather than examining the factors that need to be overcome to reach environmental sustainability.

Zsidisin and Siferd (2001:61) in their review of the environmental purchasing literature identify that many of the research studies in this area are exploratory and attempt to derive rudimentary definitions and understanding of the scope of environmental purchasing. In fact, they believe that published academic research in environmental purchasing only covers a fraction of the experience and practices found in many organisations, making theory development a challenging task. In their review of 35 key articles these authors note a bias towards exploratory empirical work, which can be considered necessary to form a solid base for theoretically driven research, but a lack of studies that test theory is apparent (only 9% of studies they identify test theory). They consider that the integration of established theories into environmental purchasing research is needed and should be used for future empirical studies.

Green *et al.* (1996) also note the primarily anecdotal nature of companies' green purchasing policies, with few comparative studies. Carter and Ellram

(1998) argue that despite early attempts a grounded theory of the framework for greening the supply chain is lacking. Carter and Ellram (1998) make the same criticism with reference to the specific area of reverse logistics noting the descriptive, anecdotal nature of prior research, with mostly a practitioner orientated focus and appearing only in trade publications. Carter and Ellram (1998) also state that only few authors discuss reverse logistics from a holistic perspective (e.g. Cairncross 1992; Murphy *et al.* 1994; Stock 1992), where all aspects of reverse logistics are examined as part of an integrated process of environmental improvements. Most reverse logistics research is exploratory except the work by Livingstone and Sparks (1994) and Murphy *et al.* (1994, 1995).

By 1994, only three articles dealing with environment and logistics-related issues from 1990 were found in the three leading academic logistics journals by Murphy *et al.* (1994)[6]. The authors state that empirical studies are a rich area for future research in green logistics. Table 1.1 indicates that there are still few empirical survey based studies that examine green logistics (Autry *et al.* 2001; Murphy and Poist 2000, 2003; Murphy *et al.* 1994, 1995, 1996; and Rao 2002) and the majority emerge from the Murphy-based studies. Rao (2002:637) also notes the lack of empirical work stating that there is a '*dearth of empirical research concerning green supply chain management in developed countries'* and an even greater lack of this kind of research in developing nations.

There are slightly more empirical studies that examine green purchasing, as indicated in table 1.1 (Baylis *et al.* 1998a; Bowen *et al* 2001a, 2001b; Carter and Carter 1998; Carter and Jennings 2002, 2004; Carter *et al.* 1998, 2000; Min and Galle 1997; Rao 2002; Strong 1995; Zsidisin and Hendrick 1998). However, a number of these emerge from the Carter suite of studies[7], or examine restricted aspects of green purchasing in a specific sector (such as Strong (1995), who examines the opinions of grocery retail buyers), or

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6 Logistics and Transport Review, Transportation Journal and Journal of Business Logistics
7 many of these use the original 1998 data set along with additional information

restricted regional locations (such as the Baylis *et al.* (1998a) study based on SMEs in South Wales).

1.3.3 Lack of focus on the whole of the Supply Chain

Svensson (2003:313) states that '*current theory generation of supply chain management frequently departs towards suppliers, and sometimes customers but rarely both'*. This statement can also be viewed in light of his other major criticism of general supply chain research, relating to the lack of cross-disciplinary integration into supply chain theory generation. Both of these comments suggest that generating theory from an environmental perspective across the whole of the supply chain would be an important addition to supply chain management theories.

The work of authors such as Carter and Ellram (1998) and Kopicki *et al.* (1993) all show the clear need for an element of reverse logistics to be included in any green supply chain management research, such as the work by Walton *et al.* (1998). Van Hoek (1999) believes that systematic and holistic research is more relevant for understanding the impact of business practices on the environment. This is a view endorsed by Beamon 1999; Hall 2000; Madu *et al.* 1995; New *et al.* 1997; Van Hoek 1999; and Wu and Dunn 1995. In fact, Hall (2000) specifically states that research has to move beyond reverse logistics into the development of the green supply chain. This is a view echoed by Wu and Dunn (1995), who state that studies are needed that go beyond reverse logistics in one supply chain or in just one company.

Whilst there are a range of empirical (survey) studies that examine one aspect of green supply chain management (table 1.1), only one takes an integrated, whole supply chain approach (Rao 2002). Five of these empirical studies are associated with the Carter data (Carter *et al.* 1998, 2000; Carter and Carter 1998; Carter and Jennings 2002, 2004), which only examines environmental purchasing issues. Further more, the five Murphy studies (Murphy *et al.* 1994, 1995, 1996; Murphy and Poist 2000, 2003) all examine green logistics issues and are mostly based on the 1994 data. The remaining empirical studies again examine only one aspect of green supply chain management, such as reverse logistics (Autry *et al.* 2001), drivers and benefits of environmental management (Hill 1997; Livingstone and Sparks 1994) and supply chain management capabilities (Bowen *et al.* 2001b).

Therefore, the majority of the studies identified in the literature review (and appendix 1.1/ table 1.1) do not systematically examine both the purchasing and logistics functions either outside of one single case example or in a non-anecdotal fashion. The work by Rao (2002) is a good example of a broad supply chain management study but is restricted only to *'leading edge firms'* who have accredited to the environmental management standard ISO14001 in S.E. Asia. The Bowen *et al.* (2001b) study tackles a broader perspective across the supply chain but focuses on management capabilities only.

1.3.4 Geographical and Sectoral Bias – the need for a cross-sectoral sample

Table 1.1 indicates that the majority of previous empirical studies demonstrate a sectoral bias and/or a geographical bias. The Carter and Murphy group of studies all occur in the US amongst manufacturers or merchandisers, as does the work by Florida (1996), who examines the manufacturing sector, Min and Gale (1997), who examine heavy producers of scrap metal and Autry *et al.* (2001), who examines electronics retailers.

Some empirical work has previously been undertaken in the UK but again this demonstrates a geographical and sectoral bias with Hill (1997) examining manufacturing in Yorkshire, Baylis *et al.* (1998a, 1998b) investigating manufacturing in South Wales, and Livingstone and Sparks (1994) focusing on Scottish exporters. UK-wide empirical studies tend to focus only on limited sectors (Strong 1995) or functional aspects such as the role of environmental issues in marketing and sales packaging (Prendergast and Pitt 1996) or the opinions of purchasing managers on selected topics (Zsidisin and Hendrick 1998). Even when research focuses on one sector, this tends to be on a sub-category of a particular sector, with Hill (1997) noting the lack of research in a cross section of manufacturing with mostly a focus on multinational and large firms in the most polluting sectors.

Case-based research studies (identified in section 2.5) also mirror this sectoral and geographical bias. Since case-study based, prior, research studies are exploratory and anecdotal in nature, when they do cut across geographical or sectoral boundaries they do not allow theory testing through statistical techniques, merely suggesting exploratory propositions for future research.

The above discussion suggests the need for cross-sectoral studies. Only the studies by Bowen *et al.* 2001a, 2001b; Ghobadian *et al.* 1998; Rao 2002; and Zsidisin and Hendrick 1998 select 'random' cross-sectoral samples on aspects of green supply. Other studies (Autry *et al.* 2001; Baylis *et al* 1998a, 1998b, 1998c; Carter and Carter 1998, Holland and Gibbon 1997; Min and Galle 1997, Murphy and Poist 2000, Murphy *et al.* 1994, 1995, 1996; Prendergast and Pitt 1996, Preuss 2001; and Zhu and Geng 2001) examine an aspect of green supply but specifically select a limited number of sectors and sub-sectoral groups. Bowen *et al.* (2001b:179) argues the benefits of cross-sectoral research stating that previous studies such as Carter and Carter (1998) and Carter *et al.* (1998) provide biased insights as they only use respondents from '*environmentally engaged*' industries. Similarly Zsidisin and Hendrick (1998) select a random cross-sectoral, international, sample for their study of green purchasing, arguing that this produces a more balanced range of opinions. The importance of a diverse sample is argued by Andersen (1991) who states that when the purpose of research is theory generation and testing that the most 'different' cases as opposed to the most similar should be used, again supporting the use of a cross-sectoral sample. Baylis *et al.* (1998b) identifies that industrial perceptions of environmental pressures are far from uniform and that researchers should pay more attention to the heterogeneity of industrial behaviour. Mol (1995 cited in Baylis *et al.* 1998c:294) expands on this point stating that *'it is necessary for policy makers, practitioners and academics to understand that these relationships exist and companies react in different ways to the same stimulus'*. These comments suggest that a generic model of green supply chain management should be developed from a cross-sectoral sample. The influence of the heterogeneity of industry indicates that organisational contingencies could be examined statistically to see whether certain relationships are in fact 'moderated' by the nature of the organisation, in terms of factors such as sector, size, level of supplier dependency or level of environmental risk. This idea links to that of 'contingency theory' whereby different environments place different requirements upon organisations (Lawrence and Lorsch 1967). The influence of different organisational contingencies[8] is examined in the development of the model in chapter 3 (see section 3.3.4). However, table 1.1 also identifies the different types of demographic characteristics/ organisational contingencies examined in the most influential prior studies.

1.3.5 Summary of research gaps

This study seeks to address these general criticisms of previous green supply chain management studies by:

- developing theoretical framework well grounded in the literature (after Carter and Ellram 1998);
- using a study that goes beyond one supply chain or a single organisation (after Wu and Dunn 1995);
- adopting a systematic, holistic research approach, which includes logistics and purchasing (after Beamon 1999; Hutchinson 1998; Wu and Dunn 1995; and van Hoek 1999); and
- focussing on empirical rather than anecdotal research (after Carter and Carter 1998; Carter and Ellram 1998; and Zsidisin and Siferd 2001).

The gaps in previous research identified in the preceding section are general and apply to the majority of previous studies on aspects of green supply chain management. Appendix 1.1 presents a summary of the main prior studies

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8 The 'organisational contingencies' in this study are assessed using the 'demographic characteristics' of respondents. From this point onwards organisational contingencies refer specifically to these particular demographic characteristics examined in this study. However, it should be noted that only *some* demographic characteristics are tested in this study. These are examined in more detail in chapter 6

used in this research, and these are examined in table 1.1. These studies also identify a number of specific research gaps in each particular study that the author(s) recommend might be addressed in any future studies. An overview of these specific gaps in research is presented in appendix 1.2. Some of these specific gaps are examined during the development, exploration and statistical testing of the green supply chain model presented in this thesis.

Key research gaps addressed specifically within this study are as follows:

- the integration of existing research and theories into research studies on green supply chain management (Carter *et al.* 1998, 2000; Carter and Ellram 1998; Carter and Carter 1998; Faruk *et al.* 2002; Klassen and McLaughlin1996; Murphy *et al.* 1994, 1995, 1996; Zsidisin and Siferd 2001);
- exploring the means by which environmental improvements are being made through the supply chain (Green *et al.* 1996; Handfield *et al.* 1997);
- detailed examination of the internal and external forces that drive green supply chain behaviour (Baylis *et al.* 1998a, 1998b; Cramer 1998; Florida 1996; Hass 1996; Hill 1997; Linnanen and Halme 1996; Meffert and Kirchgeorg 1993; Morton 1996; Pohlen and Farris 1992; Shrivasta and Schot 1992); specifically, the role of legislation as identified by Pohlen and Farris (1992); the role of customer pressure (New *et al.* 1999; Shrivasta and Schot 1992); and the relationship between sector and other classifying criteria and the type of pressure exerted through the supply chain (Baylis *et al.* 1998a, 1998b); and
- obstacles faced by companies implementing green supply chain management (Handfield *et al.* 1997; Min and Galle 1997; Schaefer and Harvey 1998)

In addition, some of the specific research gaps identified in appendix 1.2 are partially addressed during the exploration and statistical testing of the green supply chain management pressure/response model presented in this research, namely the:

- replication of the assessment of '*progressive, moderate* and *conservative*' attitudes to the environment as proposed by Murphy *et al.* (1996), extended to include green supply chain management rather than just logistics;

- differences in inter-corporate power and how that affects green supply chain management responses and the green multiplier effect (Green *et al.* 1996; Hall 2000)[9];
- the role of partnerships, agreements or strategic alliances in the supply chain and how that might influence environmental behaviour (Baylis *et al.* 1998b; Gupta 1995; Hass 1996; Kybert 1993; Paul 1996; Pohlen and Farris 1992; Robinson 1991); and
- analysis of the findings with reference to the Murphy and Carter studies (Carter and Carter 1998; Carter *et al.* 1998, 2000; Carter and Ellram 1998; Murphy *et al.* 1994, 1995, 1996).

There is a wealth of interesting research being undertaken that examines one or more aspects of green supply chain management (see appendix 1.1). However, the initial development of green supply chain management research has tended to focus, and rightly so, on anecdotal research that assists the formulation of theory. The empirical studies that have taken place so far have tended to focus either on green purchasing or green logistics and are sectorally or geographically biased. More detailed, contextual analysis of data in qualitative cases have tended to focus on narrower sub-elements of green supply chain management or have explored green supply chain management in a limited number of organisations leading to theory development but not testing. The role of public-sector organisations is not well represented in green supply chain research (apart from the New *et al.* 1999; Green *et al.* 1996, 1998 studies), nor is the role of SMEs well represented (apart from Baylis *et al.* 1998b).

There is a need to develop theory to explain what occurs in supply chains and their management from an environmental perspective (Faruk *et al.* 2002). This

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9 see also appendix 12

study addresses the general criticisms of prior green supply chain management research by developing a grounded, theoretical green supply chain management pressure/response model that is examined in multiple organisations, in an empirical rather than anecdotal manner, and using a systematic, holistic approach which includes green logistics, internal environmental operations management and green purchasing.

1.4 Aims and Objectives of the Study

To overall aim of this study is to develop and statistically test an exploratory model of the pressures driving green supply chain management and resultant management practices. This is achieved via a series of linked objectives detailed in section 1.4.1. As part of this process the research gaps identified in section 1.3 are addressed, as detailed in section 1.4.2.

1.4.1 Specific Objectives

Objective 1: To review the theoretical basis of green supply chain management from a holistic perspective, incorporating both an upstream and downstream approach by examining green purchasing (including supplier management), internal environmental operations management, strategic environmental policies and green logistics, chapter 2 and 3).

Objective 2: To identify and model, through analysis of secondary case examples, the operational framework of green supply change management and the factors in the macro and micro environment that may influence the type and level of management response (chapter 3).

Objective 3: To explore the findings of the research instrument and empirically test the pressure/response model developed to explore the relationship between the possible external drivers, internal factors (including internal drivers, the environmental attitude of the organisation and possible obstacles) of green supply chain management, operational responses and the potential moderating effect of organisational contingencies upon these relationships:

(3.1) to explore each of the three elements of the green supply chain management pressure/ response model (chapters 7, 8, 9);

(3.2) to test whether each of the elements of the green supply chain management model are individually affected by organisational contingencies:

- the external drivers are examined in section 7.5
- the internal factors are examined in section 8.6
- the operational practices are examined in section 9.4;

1.4.2 Addressing the research gaps in green supply chain management

During the process of fulfilling the objectives detailed above, a number of gaps in green supply chain management research, as discussed in section 1.3, are addressed. Table 1.2 shows where each of these is addressed within this study

Table 1.2: Research gaps addressed during this study

RESEARCH GAPS ADDRESSED	LOCATION WITHIN STUDY
General research gaps addressed in study	
Developing a grounded theoretical framework of green supply chain management	Model presented in chapter 3 and developed from literature presented in chapter 2, in summary in appendix 1.1 and secondary case examples in appendix 3
Adopting a systematic, holistic research approach, which includes logistics and purchasing	Research instrument (detailed in chapter 5) focuses on the whole of the study chain
Using a study that goes beyond one supply chain or a single organisations	Multiple respondents used in study, as detailed in chapter 5, representing 149 organisations from a cross-sectoral sample
Focussing on empirical rather than anecdotal research	Empirical survey research instrument used and statistical findings presented in chapter 7-10
Key research gaps addressed specifically within this study	
The integration of existing research and theories into research studies on green supply chain management	The literature examined in section 1.3, chapter 2 and appendices 1.1 and 1.2 are used to develop the theoretical framework. Secondary case examples (detailed in full in appendix 3) and the literature are used in chapter 3 to develop the green supply chain management pressure/response model
Exploring the means by which environmental improvements are being made through the supply chain	Chapter 9 specifically examines all the different types of operational green supply chain management practices in the sample (section 9.3)
Detailed examination of the internal and external forces that drive green supply	Chapter 7 examines the external drivers and chapter 8 examines the internal drivers, including environmental attitude
- the role of legislation	Examined in section 7.3.1 and section 7.5.1

RESEARCH GAPS ADDRESSED	LOCATION WITHIN STUDY
- The role of customer pressure - the relationship between sector and other classifying criteria and the type of pressure exerted through the supply chain	Examined in section 7.3.3 and section 7.3.3 Examined in section 7.5 (external drivers), section 8.3.2 (internal drivers), section 8.4.2 (environmental attitude)
Obstacles faced by companies implementing green supply chain management	Examined in section 8.5
Research gaps partially addressed during exploration of the different aspects of the green supply chain model	
Replication of the assessment of 'progressive, moderate and conservative' attitudes to the environment (after Murphy *et al.* 1996) and influence on operational activity	Section 8.2.2 development of attitudinal typology Section 8.4: general examination of typology and variability in relation to organisational contingencies Section 9.5.2: influence of attitudinal typology on specific operational activities chapter 10: role in predicting green supply chain management operational activity
Differences in inter-corporate power and how that affects green supply chain management responses and the green multiplier effect	Use of supplier dependency and customer dependency as organisational contingencies in the statistical testing of each element of the model. These criteria are developed in chapter 3
The role of partnerships, agreements or strategic alliances in the supply chain and how that might influence environmental behaviour	Examined in terms of industrial networks and supplier outreach activities in chapter 9. Also examined in detail outside of this study and presented in appendix 12
Analysis of the findings with reference to the Murphy and Carter group of studies	Discussion of findings in chapters 8 and 9 examine these studies, especially the work of Murphy in relation to the environmental attitude typology. As the major prior empirical studies on green purchasing (the Carter *et al.* suite of studies) and green logistics (the Murphy *et al.* studies) they are used within the formulation of the green supply chain model and the research instrument

1.5 Development of the Pressure/Response Model of Green Supply Chain Management

As noted earlier in this chapter, the aim of this thesis is to develop and empirically test a pressure/ response model of green supply chain management. The theoretical foundation of this model is presented in chapter 3. This model is summarised in figure 1.2.

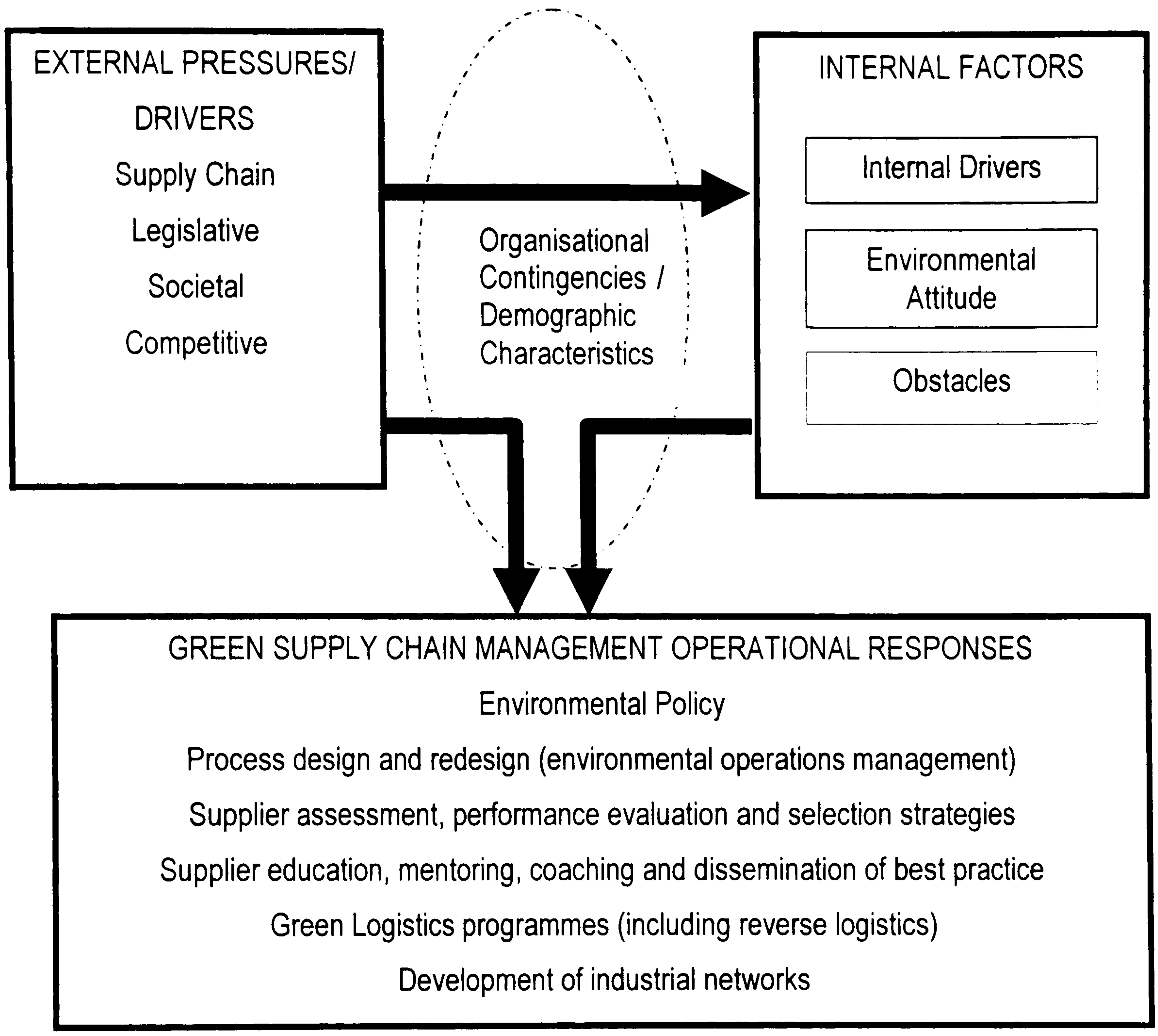

Figure 1.2: Theoretical pressure/response model of the drivers of green supply chain management and potential operational responses

The final exploratory pressure/response model is presented in chapter 10 (section 10.6) and each of the three elements of the model are explored individually in chapters 7, 8, and 9. The potential moderating influence of organisational contingencies are introduced in section 3.3.4 and tested in each of the individual elements of the model (again in chapters 7-9) and in the final exploratory model in chapter 10.

1.6 Thesis Method

The method employed in this thesis is summarised below.

Stage 1: Literature Review and Model Development

- Extensive literature review on one or more aspects of green supply chain management (*Chapter 2).*
- Development of the pressure/response theoretical model of the drivers of green supply chain management and possible management response (*Chapter 3).*
- The identification of research questions from previous research studies, to provide external validity when used as part of the research instrument for this thesis (*Chapter 2 and section 5.3.1).*

Stage 2: Development of the Research Instrument *(Chapter 5)*

- The development of an empirical research instrument to test the theoretical pressure/response model.
- The circulation of the research instrument and objectives to the environmental special interest group of the Chartered Institute of Purchasing and Supply (CIPS).
- Redraft of the research instrument in light of the comments of the CIPS panel.
- Piloting of the research instrument. Seventeen senior managers or CEOs of the CIPS database were asked to complete the questionnaire and suggest revisions to the survey, with 10 responses received from this pilot stage.
- The research instrument was redrafted to reflect the comments of the pilot group.
- Database sort at CIPS headquarters to select a targeted sample of CEO's or Senior Managers involved in 'supply', 'purchasing', 'environmental' roles or whose specific skills stated 'supply, environmental or purchasing'. [10]

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10 The database comprises of 'members' of CIPS, some of whom come from the same organisation. Therefore the database sort selected members who met the criteria detailed and

- Distribution of the survey research instrument to 1457 members of the CIPS who fit the criteria specified in the database sort.

Stage 3: Data Analysis and Validation of Model

- Examination of each element of the green supply chain management pressure/response model *(Chapters 7-9).*
- Analysis of the findings to establish statistically-significant relationships in the model between external drivers, internal factors and resultant management responses *(Chapter 10).*
- Validation of the pressure/response model of green supply chain management *(Chapter 10).*
- Development of a exploratory pressure/ response model of green supply chain management *(identified in section 10.6).*

1.7 An overview of the Structure of the Thesis

Chapter one presents an introduction to the thesis, including aims and objectives, methodology and an introduction to the theoretical model to be tested. A critique of the literature is also presented, identifying the general criticisms of previous green supply chain management research and the specific research gaps that can be identified in this area.

Chapter two presents a detailed literature review on green purchasing, supplier management, green logistics and green supply. The influential previous research studies are identified and examined in appendix 1. A summary is presented of each of these influential studies identifying their contribution, methodology and gaps.

Chapter three presents the development of a generic 'pressure/response' model of the drivers of green supply chain management and possible management responses. This model forms the theoretical basis of the thesis

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then selected the highest-ranking member of each organisation – so that only one respondent from each organisation was approached.

and comprises of the three elements of external drivers, internal factors and operational activity.

Chapter four presents an examination of theory of management research including research philosophies, choice of research mode and research techniques.

Chapter five examines the actual methodology used in this thesis, including aspects such as choice of research technique, stages of the research process, data collection and analysis.

Chapter six is predominantly descriptive and presents an overview of the demographic characteristics (organisational contingencies) of the respondents to the survey.

Chapter seven is the first of three chapters that analyse in detail the findings from the primary data collection process. The next three chapters are structured to reflect the three elements in the inductive pressure/response model. The first chapter, chapter seven, analyses the external drivers of the model. Chapter eight examines the internal factors including the internal drivers, environmental attitude and internal obstacles. Chapter nine analyses the management practices of the respondents in the sample. As each of the three elements of the model are explored, the influence of the demographic characteristics of the respondents are examined to see if they significantly influence the intensity of the external drivers, internal factors and green supply chain management operational activity.

Also in chapters seven, eight and nine the data collected during the survey is transformed to make it more suitable for statistical analysis. This involves the development of numerical scales for the four external drivers, internal drivers, environmental attitude, internal and supplier obstacles, and operational practices in each of the six operational categories of activity.

In chapter ten the findings from the previous three chapters are brought together to develop multiple regression models of the pressure/response green supply chain management model in order to identify the most influential relationships within this model and how these relationships may be affected by organisational contingencies.

The concluding chapter (chapter 11) presents a summary of the findings, identifies the main contribution to knowledge made by this thesis and its limitations.

CHAPTER 2: GREENING THE SUPPLY CHAIN – LITERATURE REVIEW

2.1 Purpose and Structure of Chapter

The purpose of this chapter is to present a review of the literature in the area commonly described as green supply chain management. A brief introduction to green supply chain management is presented in section 1.2, defining green it as the integration of upstream activities such as green purchasing and supplier management, with internal environmental operational practices, and downstream activities associated with green logistics, to improve the environmental performance of individual organisations and those directly linked to them in a supply chain.

The literature in this chapter examines theory or practice in one or more elements of green supply chain management including aspects associated with green purchasing, internal environmental management and green logistics. The literature reviewed in this study covers any individual element of the flow of materials, information, values or standards through the supply chain, from the supplier (upstream) or customer (downstream) end of the supply chain to improved environmental performance. The main focus is on the specific management practices associated **directly** with green supply chain management. Therefore, whilst internal management practices are examined in the research instrument used in this study, this only relates to those practices associated with greening the supply chain[1].

Therefore, this literature review firstly examines upstream environmental management practices associated with green purchasing and supplier management (including specific supplier outreach activities). Secondly, it

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1 An overview of general internal environmental management practices and environmental policy is presented in appendix 2 (section 2.6), examining general issues associated with cleaner production, life cycle assessment, eco-efficiency, and environmental management systems

examines management practices associated with downstream activities and green logistics.

This division between upstream (supplier) and downstream (customer) operational practices is in some ways misleading, as Hill (1997) notes that every organisation is someone's customer and therefore purchasing and logistics are intertwined. However, the discipline of supply chain management grew out of research into aspects of purchasing and logistics/ transportation, and only recently has evidence of a more holistic assessment of green supply chain, which considers logistical and purchasing functions together, emerged in the literature (Tan 2001). This chapter is structured to reflect this historical, if somewhat artificial, division. The logic for the literature review and it's boundaries is also discussed in section 4.4.2

2.2 Upstream Steering - Green Purchasing and Supplier Management

Chapter 1 notes that green purchasing is one aspect of the wider concept of green supply chain management. In the following section a literature review of green purchasing and supplier management is presented.

2.2.1 Green Purchasing – General Overview

Johnson and Lewin (1996:1) define organisational buying behaviour as a multiphase, multiperson, multidepartmental and multiobjective process. This is a dynamic and intricate process with a complex set of issues and situational factors that directly, or indirectly, influence a buying firm's behaviour. Arguably, this picture of organisational procurement becomes even more complex when the additional 'layer' of environmental responsibility is added.

Procurement is a key function in business, with organisations in the chemical and car manufacturing industries finding that their purchases can amount to approximately 70% of turnover (Baily and Framer 1990). Hutchinson (1998) states that up to 75% of IBM UK's annual costs relate to bought-in products and services, with £1.6 billion spent in 1992 amongst 2000 of their suppliers

(Gillett 1993).

Lamming and Hampson (1996:45) state that a *'potentially effective way of managing company environmental policy is by linking it closely with the activities of the purchasing function'*, with the UK Round Table on Sustainable Development (1997) stating that *'all organisations - but especially large companies and public sector organisations - should use procurement as a way of encouraging those in the supply chain to improve environmental performance'* (cited in Wycherley 1999:120). Walton *et al.* (1998) note that companies who want to reap the greatest benefit from their environmental management processes must integrate other members of the supply chain into their planning and operational processes, which requires companies to include suppliers if they truly want environmentally friendly practices for purchasing and materials management.

The importance of the green agenda within purchasing is undeniable. It is the mechanism by which an organisation can address some of the life cycle issues of its products and reduce its own environment impact. Purchasing is also the *'gate-keeping'* function, controlling what materials and services come into a business.

Monczka and Trent (1995) identify the impact of environmental regulation as the second highest issue of concern for purchasing professionals. Min and Galle (1997) also note the relationship between green purchasing and regulation. In their study of the purchasing strategies of members of the National Association of Purchasing Managers (NAPM) in the US, they identify green purchasing strategies as 'reactive' in that they focus on avoiding environmental liabilities, rather than embedding environmentalism into corporate goals. This seems to support the view of Russel (1998) who presents an overview of greener purchasing and notes that it appears to be the *'Cinderella'* of environmental management, with companies who pay attention to their production patterns, and subsequent waste by-products, still paying little attention to consumption patterns. He notes the Business in the Environment (BiE) survey that found *'the biggest gap to close is the creation* *of environmental programmes with suppliers'* (BiE 1993: cited in Russel 1998:10). Yet, as Walton *et al.* (1998) argue the purchasing function is critical to the success of any environmental management programme, as it is located at the start of the value chain.

The adoption of environmentally sound procurement practices may offer significant competitive advantage due to the public demand for environmentally safe products and potential reductions in cost (Klassen and McLaughlin 1996). The International Hotels Environmental Initiative (IHEI 1996:109) discuss the concept of 'precycling', which makes purchasing decisions to support responsible products and packaging, which make recycling and disposal easier and reduces costs associated with waste. Carter *et al.* (2000) debate whether socially responsible actions by firms' result in improved financial performance. The authors note that whilst purchasing can create value upstream, as well as affecting environmental operations performance, there is a question of whether it affects the financial 'bottom line'. Min and Galle (1997) suggest through anecdotal evidence environmental purchasing can affect a firm's economic position through reduction of waste, liability issues, and improved eco-efficiency and image enhancement. The Carter *et al.* (2000) study on the relationship between green purchasing and economic performance identifies a significant relationship with net income and cost of goods sold, providing empirical evidence linking environmental purchasing[2] to firm financial performance.

Green purchasing can be used to substitute one product for another, selecting a product that has a lower environment burden, or to choose an '*environmentally responsible'* supplier. Green purchasing may have a critical role to play in the design of products for the 'environment' by suggesting alternative sources of raw materials and by involving suppliers early in the design process to reduce environmental impacts. An example of this is the company 'Scotsman', whose cross-functional purchasing team developed the

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2 Some authors use the phrases 'environmental purchasing' or 'environmentally responsible procurement'. In this study these terms are interchangeable with the term 'green purchasing'

freon-free refrigerant and compressor, as reported in Carbone (1995).

Morton (1996) notes that green purchasing has five features in common with the general purchasing literature:

- Firstly, supplier development/partnerships could encompass initiatives to develop dialogue, mentoring and/or coaching for environmental improvement;
- Secondly, rationalising an organisation's supplier base, where the environmental performance of suppliers is used as part of the process of streamlining the supplier base. For example, the reduction of SMEs in Nortel's supply chain after an 'environmental' supplier audit (cited in BiE 1997), or using the environment as a specific criterion by companies wishing to reduce their supplier base (Green *et al.* 1995);
- Thirdly, the use of lean supply for eco-efficiency gains;
- Fourthly, the involvement of purchasing, R&D staff, environmental managers and internal customers in the development and design of products; and
- Finally, an increasing concern for total costs or whole life costing whereby environmental costs are integrated into the acquisition process.

Strong (1995) examines the use of environmental criteria by grocery retail buyers, with 57% of buyers setting environmental standards for suppliers (as illustrated in table 2.1). This study, which includes a survey of 66 retail buyers employed by the UK's eight largest grocery retailers, examines the influence of environmental issues in the purchasing decision making process and these include:

- the environmental impact of the products contents;
- recyclability of the product;
- recyclability of the packaging;
- degradability of the packaging;
- recycled content of the packaging; and
- the environmental impact of the manufacturing process.

Table 2.1: Relationship of suppliers with grocery retail buyers (Strong 1995)

Relationship between Grocery Retail Buyers and Suppliers	Results (n=22)
Environmental standards set that suppliers were required to meet?	57% required to
Supplier research aimed at evaluating the environmental impacts of products, materials and processes?	48% carried out supplier research ranging from internal investigations to independent audits
Are suppliers questioned on environmental impact of their products?	38% normally do, 33% occasionally, 19% always do but 10% never did. A higher number of non-food buyers questioned suppliers than those buying food products.
Were suppliers checked to see if they adhered to green code?	19% never challenged, 10% always did, 37% normally validate claims and 33% occasionally did. Again the buyers of non-food products challenged claims more frequently

Elwood and Case (2000) present a range of case examples in a variety of private companies (mostly multinationals or large companies) who have adopted an 'environmentally preferable' purchasing approach. Elwood and Case identify the key elements in green purchasing, based on these case examples as:

- Developing lists of chemicals to avoid;
- Creating lists of approved products;
- Establishing single-environmental-attribute purchasing programmes;
- Considering multiple environmental attributes when making purchasing decisions;
- Working closely with suppliers to enhance environmental performance;
- Tracking chemical and waste streams; and
- Defining the total cost and environmental impact of materials, processes and products.

These criteria examine both specific product attributes as well as the general environmental performance of suppliers. When organisations assess the 'green' credentials of a specific product they can examine a range of environmental credentials from a life cycle perspective (as illustrated in table 2.2).

Table 2.2: Options for assessing environmental credentials of a specific product (Boons 2002)

Activity	Description
Material reduction	Reducing the amount of one or more materials necessary for producing the product
Material substitution	Replacing one or more materials for ones that have less negative ecological effects
Material recycling	Recycling a material which constitutes the product
Product substitution	Replacing the product with another one which fulfils the same function
Product recycling	Collecting and reusing the product
Eliminate function	Stop fulfilling the function of the product

Another issue that may also be important when deciding the environmental impact of a specific product, is formally assessed is how 'crucial' the product is to an organisation. In some instances a manufacturer may be critically dependent upon one or more components that may only be available from a small number of suppliers. The 'power' in this supply chain probably rests with the seller not the buyer, and requiring environmental improvements from the supplier may not be a valid option. Conversely, if a supplier has only one customer, they must meet whatever criteria that are set by that supplier. The characteristics of specific products may also affect the limit of green supply chain management initiatives (Preuss 2001). Customers who have exact specifications may be less amenable to changes in a product's design suggested by the supplier, in order to substitute 'environmentally friendly' components. If a supplier is significantly dependent upon a particular customer then that customer's specific requirements may take precedence. Hass (1996) explores an example of the 'negotiation' process a supplier needs to go through in order to change product characteristics and illustrates how difficult it can be to convince customers to accept product changes. The influence of 'channel power' of suppliers and customers (Hall 2000, 2001) is explored further in section 2.2.5.

Baylis *et al.* (1998b) state that green purchasing has the greatest impact in the manufacturing and processing industries, where the emphasis on the life cycle of products has the greatest role to play. This is a view echoed by Hill (1997) who notes that these sectors invite a life cycle perspective due to the wide range of environmental implications that might apply to them. Kopicki *et al.* (1993) also note that supply chain managers in the retail and consumer products industries are likely to be highly involved in environmental purchasing, with Carter and Carter (1998:668) finding *'reasonably high levels'* of environmental purchasing activity in the consumer products manufacturing firms, resulting in their selection of these firms in their empirical study. The views expressed by these authors suggest that there may be some form of sectoral bias in the extent of green purchasing behaviour in organisations[3].

2.2.2 The Green Consumer

This section presents a brief discussion of the role of the 'green consumer'. This study develops and tests a model of green supply chain management which includes organisational green purchasing, rather than individual green purchasing decisions. However, the influence of environmentally committed CEOs and green champions can affect the extent to which CSR practices, including green supply, are adopted in an organisations (as discussed in section 3.2.3). In addition, organisations that supply directly to the 'public' may be affected by the environmental values of these individual customers (the so-called 'green consumer'). Therefore, it is important to present a brief overview of the concept of green consumerism and green consumption patterns

A number of authors discuss the choices made by the individual green consumer (Coddington 1993; Elkington and Hailes 1988; Minton and Rose 1997; Peattie 1995; Straughan and Roberts 1999). The 1988 Green Consumer Guide by Elkington and Hailes was amongst the first examples of information that individual consumers could use to identify a broad range of 'greener products'.

More recently Peattie (1995), Ottman (1998) and Charter and Polonsky

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3 Section 1.3.4 presents an argument for the use of a cross sectoral sample in this study that investigates the influence of sector on the pressures driving green supply chain management and management practices

(1999) review the current state of knowledge on green marketing and green consumer behaviour. The demands of the *'green consumer'* prompt changes in the practice of marketing to consumers but also in the actual design of products, as seen originally in the removal of CFC's in the 1980's from aerosol products (Elkington and Hailes 1988).

The 'green consumer' in the above example is the traditional individual 'customer' for the end product of manufactured goods or services, provided by an organisation. A MORI poll in 1989 found that half the adult population of the UK had made at least one purchase where a product was selected instead of another because of its environmentally friendly packaging, formulation or advertising. A US survey found that 75% of consumers are influenced by a company's reputation with respect to the environment and eight out of ten consumers would pay more for products that are environmentally friendly (Klein 1990, cited in Drumwright, 1994). A Walter Thompson survey in the US found 64% of respondents would 'boycott' companies who had a 'dirty' image (cited in Coddington1990).

The overall environmental 'image' of an organisation may be very important as individual customers may choose to use, or not to use, a particular supplier without considering in detail the particular attributes of the product they wish to buy. Examples include the selection of products from the Body Shop or the avoidance of a certain company's products because of their ethical or environmental stance. In many ways this is a form of negative or positive branding. Branding is defined as the process whereby loyalty to a brand allows customer to forget detailed reasons why they buy a particular product. The negative reaction to Shell after the Brent Spar/Ken Sara Wiwa incidents in 1995 is a good example of negative branding and the arguably positive view of the Body Shop is an example of positive branding.

However, it is difficult to distinguish between an individual customer's choice of a supplier as opposed to the choice of a specific product, and it is often a mixture of the two. For example Peattie (1995) notes that firms have found that it is easier for a trusted brand to realign itself as having 'green' credentials, than it is for customers to develop loyalty to a new brand. One example of this is the DKK Schjar-fenstein's environmentally responsible fridge. After the initial launch of this new 'green company/product' other European mainstream manufacturers launched competing products by changing the specification on current ranges. Loyalty to the brand of the mainstream companies by consumers meant that since the '*green credentials*' of the traditional product were now in place, customers returned to them rather than the newer unknown firm (DKK), even though it was a 'green' company (Peattie 1995).

Kardash (1974) states that everyone could be classed as an ecologically concerned consumer. Most green consumerism research suggests that all other factors being equal an individual will choose to buy green (Roberts 1996). However, that may only be the case as long as the price, quality, convenience are the same as the original. This also presumes a state of 'transparent' knowledge, where full disclosure on the possible environmental impacts of a specific product and the organisations involved in it's production and distribution, are fully known by the consumer. Coddington (1990) suggests that 79% of Americans consider themselves environmentalists, 82% have recycled, 83% have changed their shopping habits to help protect the environment and 67% state they would be willing to pay 5-10% more for environmentally compatible products. Whilst, Hume *et al.* (1989) note that 90% of Americans surveyed would be willing to make a special effort to buy products from companies trying to protect the environment. Yet, actual environmental actions do not often follow these espoused values (see Holt and Anthony 2000). This 'green purchase gap' has led Peattie (1995) to suggest that it is easier to analyse green consumption in terms of green purchase decisions rather than focusing on green consumers. For example, in the United States and Germany product choice may be on basis of recyclability (at the end of the product's life cycle) and the individual operates green consumption behaviour by recycling the product after use, rather than adopting green purchasing principles when buying the product. This 'purchase gap' is also explored by Roberts (1996) who notes the Simmons Market Research Bureau (1991) study, which found that customers in the US did not actually buy the products they claimed to prefer. The work by Roberts (1996) discusses in detail previous green consumerism research studies and undertakes an empirical investigation on 'ecologically concerned consumer behaviour' (ECCB). The ECCB study found that sex, income, education and age are all significant predictors of ECCB, with the addition of attitudinal data, aiding the explanation of variation in ECCB. In addition, those individuals who believe that they can *'do something'* about an environmental issue are more likely to demonstrate ECCBs - stressing the belief that individuals need to feel 'ownership' for a problem/issue in order to take action.

The influence of this lack of individual responsibility or ownership leading to environmental degradation is a view that was first explored by Hardin in his 1968 paper *'The Tragedy of the Commons'.* Perhaps, a perceived lack of effectiveness when faced with the scale of global environmental issues is one reason why the individual does not take action through their purchasing 'power', even when espousing strong environmental values (Holt and Anthony 2000).

Green purchasing from the perspective of a company or organisation might be thought of as a 'collective' approach, where individuals (i.e. employees) make buying choices based on the ethos, policy or guidance of the firm. Organisations can act as green consumers by consciously selecting an alternative product that has better environmental credentials, for example buying photocopy paper that is recycled. A discussion of green procurement of paper in the Nordic countries is provided by Gronow *et al.* (1998). Typically this green product choice is undertaken by the operations function of the firm, perhaps guided by environmental polices on purchasing. Organisations may also choose to substitute green products, for example the substitution of a less harmful/toxic chemical during production or replacing a type of material with one of a higher recycled content. The environmental criteria of a product/ raw material might be established via a life cycle or some other form of evaluative tool.

Organisations may also choose to buy from dedicated suppliers, based upon the environmental stance of the organisation, rather than focus on a specific product choice. As Barry (1996) notes, a growing number of firms have been following a policy of addressing their own environmental impact by focusing on suppliers. The 1996 Groundwork Report on SMEs found that customers had asked over 40% of the respondents about their environmental performance. One of the most well known examples is that of B&Q, reported in Barry (1996) who instigated a supplier audit and eventually required their suppliers to achieve a minimum standard of environmental commitment and action in order to remain a B&Q supplier. As Russell (1998; 9) notes '*greener purchasing is also about using suppliers who themselves meet strict environmental standards, so that greening the supply chain is an integral part of the greener purchasing process'*. Thus, irrespective of what products a firm buys from a supplier, or even the individual environmental impact of a product, the overall performance of the supplier might be the deciding factor.

The role of the individual green consumer and development of green marketing is outside the scope of this study. However, the principles underpinning green consumerism and buying behaviour may also apply at an organisational level. Individuals within an organisation are themselves part of the wider society that has become more environmentally aware, and may bring their individual values to the organisation. In fact, it could be suggested that many of the 'green champions' that are responsible for developing environmental management programmes in firms are exhibiting high levels of what Roberts (1996) called '*perceived customer effectiveness'*. Hill (1997) draws the distinction between green consumer pressure and industrial customer pressure. The firm as a supplier within a supply chain may be some distance from the final end user, the individual customer. Thus, the role of an *industrial customer* in a supply chain is vitally important and maybe influenced through a series of intermediary organisations that supply the final *individual customer*.

There is a lack of research on organisational purchasing behaviour of products with strong environmental attributes (Polonsky *et al.* 1998). The range of green purchasing examples presented by Russel (1998) goes some way to developing theory of the green purchasing field, however, only the work by van der Grijp (1995, 1998) and Gronow *et al* (1998), refers to qualitative or quantitative data specifically on the purchase of a *particular* product (in this case paper). Whilst, Strong's (1995) work, discussed elsewhere, also examines the thoughts and motivations of purchasing agents. Polonsky refers to the work by Drumwright (1992, 1994) as perhaps the most comprehensive undertaken so far on environmental purchasing, involving 63 in-depth interviews in ten organisations on the factors determining socially responsible buying in organisations.

Drumwright (1994) identifies three different types of individuals in organisations. The *policy entrepreneurs* identified as individuals who are prepared to go to personal expense to put forward important issues in the company, perhaps the so called 'green champions', who use their knowledge as a power base to prick the organisational conscience. This supports the suggestions that the individual environmental values may affect the environmental culture and operational practices in organisations. Secondly, the *converts* who eventually embrace the green purchasing policies, often after initial resistance and then perhaps with great fervency and thirdly, the *resisters,* who do not see the need to modify their behaviour. Each of these types of 'individuals' as defined by Drumwright (1994) may positively, or negatively, affect the adoption of green supply chain management practices in an organisation.

Drumwright (1994) also classifies organisations into four categories of 'socially responsible' buying, in a similar manner to the 'environmental management' typologies of Roome (1992), Ghobadian *et al.* (1998) and Welford (1999), where each of one of these four organisational 'types' describes the role of socially responsibly buying in an organisation. Table 2.3 suggests that 'green purchasing' may be formally integrated into organisational strategy or may be more of an 'ad-hoc' activity. Each type of organisation has slightly different reasons for adopting more socially/environmentally responsible purchasing behaviour.

Table 2.3: Classification of socially responsible buying by organisations (adapted from Drumwright 1994:15)

Have Deliberate Organisational Strategy		Have no Deliberate Strategy	
Founder's Ideals	**Symbolism**	**Opportune**	**Restraint**
Founder viewed organisation as 'pulpit' for social change. Formal stated social mission, social responsibility officer and audits for self and suppliers	Socially responsible buying (SBR) used to symbolise company efforts at socially responsible behaviour. Top management recognised that social responsibility linked to success due to public or regulatory scrutiny	Company engaged in SBR when cost savings or competitive advantage are possible. Company responding to what it perceives as the hot topic of the moment	Voluntarily exercised restraint. May be engaged in SBR at a non-negligible cost. At times company began to resemble other types

2.2.3 Green Purchasing Principles at the Level of the Firm – Generic Guidelines

Section 2.2.1 presents a general introduction to green purchasing and section 2.2.2 discusses the influence of individual environmental/social values and how they may affect organisational buying. This current section briefly introduces some of the generic advice and guidance on green purchasing given by a number of authors (BiE 1993, 1997; Cannon 1998; Carter *et al.* 1998; Elwood and Case 2000; Groundwork 1996; IEHI 1996; Morton 1996; and Strong 1995)

This guidance describes the management practices an organisation can take through purchasing to improve their environmental performance. For example, the manual on *Environmental Management for Hotels* (IEHI 1996) identifies a range of generic practices in environmentally responsible procurement. These include: reviewing all products purchased and assessing their environmental impact; reviewing all services provided and assessing their environmental impact; determining the availability of environmentally friendly alternatives; drawing up an action list with priorities based on results of review; and discussing substitution of alternatives with suppliers.

The generic guidance provided by BiE (1993) suggests that environmental purchasing considerations include:

- Specifying products and services considered to be more environmentally acceptable;
- Building environmental clauses into contracts;
- Rating supplier performance against environmental criteria; and
- Examining environmental management standards of suppliers.

Later work by BiE/CIPS (1997) details case examples of green purchasing behaviour in a series of 'leading-edge' organisations and detail generic green purchasing strategies that can be adopted by organisations. In a similar manner the operational activities of US leading edge organisations are described in the BSREF study of green supply chain management (BSREF 1997; Lippmann 1999, 2001), to produce general 'guidance' on possible operational activities and environmental strategy. Other publications such as Elwood and Case (2000) also present anecdotal examples of green purchasing programmes in different organisations. However, none of these studies systematically examines the broad range of operational activities that organisations can undertake as part of green purchasing and green supply , merely describing 'stories' of selected operational activities undertaken by each case example. Thus supporting the need for empirical research that analyses the extent of green supply chain management operational practices in a range of types of organisations.

2.2.4 Public and Private Purchasing

This study examines green supply chain behaviour in a range of sectors including the public sector. Therefore, it is important to briefly introduce some of the key differences affecting purchasing behaviour in the public sector in comparison with the relatively more flexible private sector (New *et al.* 1998, 2002; Green *et al.* 1996). The key differences specific to the public sector are detailed below (New *et al.* 2002)

- *The large size of purchases in the public sector.* Government related procurement in OCED countries may account for between 5-15% of their GDP (Cinq-Mars 1997)

- *The leverage of the public sector* where they are the only or single most important, customer.
- The *unique power* of the public sector to set commercial terms.
- The *procedural and regulatory environment*

  -The environment of legal restrictions. EU legislation affects green purchasing even more stringently in local authorities than industry, due to compulsory competitive tendering and the EC procurement regime. Under the EC Procurement Directive, contracts should be awarded on the basis of lowest price or 'most economically advantageous tender' if the contract exceeds a threshold cost. Justification of non-monetary criteria is therefore difficult. Anon (1998) states *'the government will buy green but only if it is the cheapest'*

  -Detailed compliance of scrutiny with regulation

  - The fact that there are *mechanisms in place to govern solicitation* of vendors.
- The *role public organisations can play* as an instrument of the Government's social and environmental policy.

However, New *et al.* (2002) also notes a number of similarities between public sector and private purchasing. Firstly, the difficulties of establishing links between the different groups that need to interact before environmental issues can be sensibly included in green purchasing. Secondly, that in both the private and public sectors it appears that the momentum of green purchasing initiatives can be sustained if they are aligned with a broader corporate objectives.

Russel (1998) identifies a range of examples of public procurement around the world. Bergeson (2002) and Elwood and Case (2000) examine the US federal government green purchasing programme[4], detailed below.

(1) *Recycled Contents Program* – This programme involves 54 products for

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4 Also supported by the new Bush administration that took over the US presidency in 2002.

which the recycled 'version' must be selected above non-recycled products as long as recycled alternatives are 'reasonably' available and comparable in performance.

(2) *Energy Efficient Products Program* – purchasers must select energy star labelled products in all designated categories where life cycle costs are effective.

(3) *Environmentally Preferable Purchasing Program* - requires executive agencies to identify and give preference to environmentally preferable products and services (which must include aspects from across the life cycle of the product).

(4) *Biobased Products Program* – this co-ordinates and accelerates federal biobased products, energy research and development by promoting the use of renewable biomass products.

The above examples are of US federal purchasing programmes, but individual states can also set public sector green purchasing guidelines. In the UK, some local authorities have included purchasing as an element within their Local Agenda 21. Groundwork (1996) produced a green purchasing guide specifically targeted at local authorities. The EC Procurement Directive is the most influential piece of purchasing legislation affecting the public sector, but it is does not include preferential treatment of 'green' products. Van der Grijp (1998) notes that public procurement in the Netherlands tends to be keep environmental requirements out of calls for tender due to the EU Directive and this is a similar story in the UK public sector. At the moment in the UK there is no compulsory public sector green purchasing programme that applies to all public sector organisations, whereas there are a number of compulsory federal programmes in Canada and the USA (Russel 1998).

Thus, the UK public sector organisations individually adopt different levels of green purchasing practices, within the confines of the EU Purchasing Directive. The European Commission's Green Paper (CEC 1996) state that *'the application of the public procurement directive does indeed leave scope for public authorities to promote environmental protection'*. Many local authorities are still very hesitant about incorporating environmental criteria in their calls for tender, but a number of public sector special interests groups and working parties are developing green procurement programmes[6].

2.2.5 Supplier Management and Education

Green purchasing allows an organisation to buy more environmentally 'responsible' products but it is also a way of influencing, or forcing, others in a supply chain to follow suit. The following section examines the literature on suppler assessment, evaluation and education. The role purchasing plays in developing a culture of environmental responsibility throughout the whole of the supply chain is also examined.

BiE (1997:4) state that the involvement of suppliers in assisting business performance recognises that an organisation's performance could only be as good as the standards set by suppliers. Therefore, arguably an organisation's environmental performance can only be as good as its green supply chain performance. Customers and other stakeholders may not always draw the line between a company's environmental performance and it's suppliers (Rao 2002:632). Requirements of environmental standards such as EMAS and ISO14001 all recognise the key role of suppliers. In fact, urging suppliers and contractors to meet certain standards of environmental performance is amongst the sixteen principles listed in the *Business Charter for Sustainable Development* ratified by the International Chamber of Commerce (ICC 1990).

Unlike purchases by an individual who is 'free' to decide which product they wish to buy and from whom, the situation is more complex in organisational purchasing or 'industrial' consumption. Some organisations are required to

[6] The Central Buying Consortium held an environmental conference on 24 September 2002. CBC is the biggest local government purchasing and suppliers group, influencing an annual spend of about £750m. This conference launched their environmental policy and presented their plans to work with buyers and environmentalists from 17 local authority members to set up pilots to develop their environmental purchasing practices.

buy only from certain suppliers, or can only buy from a list of approved products. Aspects such as quality of materials, price and continuity of supply are of paramount importance to organisations, and this may allow little flexibility in terms of what can be purchased and from whom.

However, organisations are beginning to use environmental criteria as part of the process of selecting a product or a supplier. Lamming and Hampson (1996) review the methods of vendor assessment using environmental criteria. Supplier questionnaires are used by organisations such as B&Q and focus on aspects such as: regulatory compliance; environmental effects and performance measurement; existing environmental management procedures; and commitment to managerial and process improvement, regardless of what is supplied (Lamming and Hampson 1996).

Lamming and Hampson (1996) further note that the assessment process might seem to disadvantage suppliers. However, if assessment is approached in a collaborative manner it may be possible to provide benefits to suppliers through demonstration of best practice, investment in best available technology and attracting new customers in new markets when standards requested by the customer are recognised. This facet of supplier management involves education or mentoring of suppliers. Thus, a distinction is drawn in this study between supplier assessment/evaluation and supplier education/ coaching and mentoring.

2.2.5.1 Supplier Assessment and Evaluation

Barry (1996), Green *et al.* (1998) and Hutchinson (1998) detail the supplier assessment and selection processes of B&Q. Their *Supplier Environmental Audit* was sent to all suppliers in 1991 and found that only 8% of suppliers had an environmental policy, 29% had taken no environmental action at all and 25% did not complete the questionnaire. Communication and awareness programmes were developed which involved 12 seminars, regular briefings for buyers and individual written reports for each supplier. By 1993 only 35% of B&Q's suppliers were at the environmental equivalent of grade C or above.

In 1994 the board decided to add a commercial dimension by setting two targets. All grade F suppliers had to achieve grade C or above within 6 months and all grade D or E suppliers had to achieve a grade C within 11 months. To achieve grade C suppliers had to produce a written policy identifying key issues and make a firm commitment to dealing with them. A support programme was provided for suppliers with 100-clinics held in 1994. By the end of 1994, 94% suppliers had reached their targets. B&Q deselected ten of their 661 suppliers in the first three years of their environmental supplier audit, but the remainder that failed were given another chance and have now reached a satisfactory standard (Knight 1995).

The Body Shop International (BSI) is arguably viewed as leading proponent of socially responsible business. Wycherley (1999) examines their efforts in encouraging suppliers to improve their environmental performance. BSI has developed a three tier supplier approach whereby the top level have a close relationship with BSI, mid level suppliers are visited by BSI staff and receive supplier questionnaire, while the final tier are assessed by questionnaire only, which suggests a mixed approach to supplier management incorporating some elements of supplier coaching (which is discussed in more detail in section 2.2.5.2).

New *et al.* (2002) urge a note of caution when examining supplier assessment, suggesting that the diversity of ability amongst purchasing managers may result in a lack of environmental purchasing that may have more to do with purchasing managers individual skills and competencies, than the environmental strategy of the organisation. However, when the critical role of 'green champions' in driving environmental initiatives is examined (Drumwright 1994; Preston 2001; Roberts 1996), the positive influence that individuals can have is apparent. Arguably, the use of corporate policy statements on the environment suggests to purchasing managers a minimum benchmark of environmental activity, and the more that these policies are articulated the better informed a purchasing manager should be[6].

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[6] This study examines organisational behaviour and therefore ad hoc initiatives by individuals

However, Preuss (2001) believes environmental issues have a marginal role in organisational purchasing due to the reactive nature of the purchasing function. Lack of green purchasing behaviour might be related to a lack of organisational commitment to environmental issues, which relates to the extent to which environmentalism is 'embedded' in an organisation, perhaps reflecting the overall environmental 'culture' as discussed by Murphy *et al.* (1996). If this is the case the purchasing function might be unlikely to respond to environmental issues in the vacuum left by lack of organisational commitment. Without an organisational level imperative to justify the choice of product and supplier using environmental criteria, rather than traditional decision making criteria, then environmentally preferable purchasing is unlikely, regardless of how environmentally committed an individual is personally. Indeed, Green *et al.* (1996) believe that it is not necessarily the case that real progress on environmental purchasing necessarily follows when firms have active environmental programmes in other areas[7].

Clayton and Rotheroe (1997) identify that 26% of their sample of companies do not use certain suppliers on environmental grounds, yet the reason for their removal from the supplier base were rarely related to *only* their environmental performance. Scott Ltd. committed itself to undertaking a life cycle approach to understanding it's environmental impacts during their production of disposable tissue paper, with the initial assessment of supplier performance leading to 10% of the 'worst' suppliers being dropped. In addition, their '*best performing suppliers'* were given added preference in purchasing decisions (Kybert 1993).

Lamming and Hampson (1996) note the presence of an environmental management system as a criteria in the assessment of the environmental performance of suppliers. Gilbert (1993:9) states that an accreditation to an

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are not examined, concentrating instead on corporate wide initiatives. Selection of the appropriate survey respondents is therefore a critical element of the research design as discussed in chapter 5.

7 This study examines the relationship between internal environmental management practices and green purchasing in chapter 9, and a lack of a significant intercorrelations between these

environmental management standard[8] (EMS), such as EMAS or ISO14001, can '*distinguish between the environmental integrity of companies ...... using performance a yardstick.* Such standards are used as surrogate indicators of environmental performance, rather than having to manage the complexities involved in detailed supplier assessment. Pesonen (2001) also notes the use of accreditation to an EMS as a way to communicate the environmental performance of an organisation, with leading Finnish contractors increasingly asking for an EMS from suppliers and subcontractors, and in some cases actually setting deadlines for when they expect their suppliers to achieve such accreditation.

However, organisations are also increasingly examining the environmental performance (and environmental risk) of suppliers from more than just the standpoint of whether they have an EMS, as evidenced by the approaches of B&Q, Rover, Hoover (as detailed in Barry 1996) and BT (ENDS 1995). IBM categorise the risk they face with their 2000+ suppliers and the extent to which IBM could be judged responsible in the event of environmental wrongdoing. The six IBM key risk factors are: geographical proximity to suppliers; extent to which product design is specified; use of contract workforce; hazardous materials and processes; waste disposal; and the level of dependency of the supplier on IBM business (Hutchinson 1998).

Yet, the criticisms of an EMS as a performance standard for suppliers echo many of the criticisms of TQM standards, involving bureaucracy for suppliers, extensive documentation and cost. In addition, accreditation to an EMS does not guarantee that a firm is more environmentally responsible than its peers, but merely that it has clear control systems in place. Baylis *et al.* (1998b) argues that more attention should be directed to working with suppliers to improve environmental performance, rather than using questionnaires to assess their environmental performance. The use of an EMS, or even the more superficial presence of an environmental policy, as indicator measures

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two measures in the study would support this assertion

[8] Accreditation to an environmental management standard formally assess an organisation's

of a supplier's environmental performance are measures that can easily be used in supplier 'audits' using questionnaires, but may say little about the actual environmental 'sustainability' of an organisation. A major criticism of most supplier selection models developed to address environmental issues (such as Enarksson 1998), is that they focus on the achievement of a *minimum* environmental standard of performance. It could also be argued that companies should be seeking higher benchmarks than simple compliance with minimum environmental standards (Walton *et al.* 1998).

Addressing the environmental performance of suppliers is not a solely altruistic process. Min and Galle (1997) identify the most important environmental influences on supplier selection as potential liability, cost associated with the disposal of hazardous materials and compliance with state and federal legislation. Hutchinson (1998) draws attention to the comments of BT, Unipart Group of Companies and IBM, where the 'good for the environment' argument is played down in favour of the commercial advantages or risk reduction of the organisation by working with suppliers.

> *'by helping its suppliers in a disciplined and structured approach to compliance, IBM anticipates benefits not only in terms of it environmental credentials, but also in reduced costs and quality improvements..... but failure of suppliers to comply (with eco labelling requirements)... could mean that IBM would lose the right to use the label and forfeit the competitive advantage it be gained from early compliance'* (Gillet (1993) cited in Hutchinson 1998:168).
>
> *'as environmental standards tighten, disposal costs rise....disposal costs have a direct impact on BT's bottom line. Such costs can be minimised- and in some cases totally eliminated- by consideration at the procurement stage. BT sees a strong correlation between environmental issues and quality. The view that environmental performance is a quality issue, with waste and poor performance being linked to quality failure, has been accepted by the organisation'* (Hepher (1994) cited in Hutchinson 1998:168)

Unipart, in their buyer notes, draw attention to the risk of dealing with suppliers who have not demonstrated compliance with relevant legislation.

> *'..if a company is prosecuted, or worse if operations are stopped by the regulators, it could lead to a disruption in supply and/or extra cost* (UCG

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environmental management system

(1997) cited in Hutchinson 1998:167)

Nagle and Blackburn (of Baxter's global healthcare products) emphasis this risk of associating with suppliers with a poor CSR performance, stating that:

> *'It has become more important to use, from a business point of view, to think about the supply continuity issue. This is not just a matter of good ethics. If you've got a supplier for a critical component who has a lousy health and safety programme and it catches fire or blows up, you're left with no product'* (Anon 1997:26).

Perhaps, what is needed is the development of supplier evaluation methods that differentially assess the riskiest suppliers first, as a form of ecological triage (after Holt and Viney 2001). McDonagh (1999) supports the idea of a priority system for assessing the ecological credentials of suppliers, referring to Peattie's (1995) continuum of high-low impact suppliers.

Apart from the use of supplier questionnaires that asks specific questions, such as information on accreditation to an EMS standard, a number of simulation and quantitative model of supplier selection exist, as reviewed by Noci (1997). These supplier selection models used in the general purchasing function include the categorical method, the weighted point method, Vendor Profile Analysis and Analytic Hierarchy Process (AHP). However, Noci (1997) notes that none of these methods explicitly consider a supplier's environmental performance. Birou and Fawcett (1994) also support this, identifying that firms select suppliers based on a formalised system that considers a wide ranging set of supplier performance criteria, but few of these models include an environmental dimension. Noci (1997) notes that AHP appears the most suitable method to incorporate environmental criteria, as it allow the introduction of tangible and intangible factors. Noci (1997) develops an AHP model that assesses the best supplier from an environmental viewpoint. However, this model does not take into account any of the non-environmental criteria normally used in assessing supplier performance, or reflect the fact the environment is one factor in a multitude of other decision criteria.

Thus, it can be argued that a situation exists where 'traditional' supplier assessment models do not include environmental issues and 'environmental' supplier assessment does not include traditional purchasing criteria. This identifies the need for new hybrid models that can simultaneously assess environmental and traditional purchasing and logistics criteria. Some of the quantitative models and simulations detailed in the summary of the major research studies presented in appendix 1 attempt to do this. In fact, Green *et al.* (1996) note that firms that already have a well established formal approach to selection and assessment of suppliers tend to find it easier to add an 'environmental' dimension.

2.2.5.2 Two Way Partnerships? Supplier Education, Coaching and Mentoring

An interesting aspect of the green purchasing debate is the role of the customer organisations in assisting suppliers, especially those smaller or less well resourced, in achieving required environmental improvements. It might be argued that prescriptive assessment of the environmental performance of suppliers disadvantages some suppliers and there is a need to assist suppliers through some form of supplier education, coaching and mentoring. Such assistance may be critical in determining whether green supply initiatives *actually* ripple down the supply chain (known as the *'green multiplier'* effect).

Canning and Hanmer-Lloyd (1998) believe that customer-supplier co-operation is necessary for initiatives such as improving the environmental performance of a product, or developing a reverse loop systems for product takeback. Customer-supplier co-operation occurs through the exchange of material or product information, making amendments to operational processes or products or facilitating returns systems. Morton (1996) notes the recommendations from BiE (1993) for a *'partnering'* approach to environmental management or co-operation strategies whereby two-way dialogue between suppliers and customers can be mutually beneficial (after Gouldson 1994). King (1996) notes examples of packaging solutions developed in the retail industry by dialogue between customers and suppliers. Hutchinson (1998) believes that environmental issues have provided catalysts for reviewing customer – supplier relationships, leading away from the traditional adversarial relationship towards one of partnership. Organisations have created networks of suppliers to build common understanding and learn about waste reduction and operational efficiencies in the delivery of existing products and services (Cox 1999 cited in Khoo *et al.* 2001).

Partnership is defined as a situation whereby:

> '..*the customer and supplier develop such a close long term relationships that the two must work together as partners. It is not philanthropy: the aim is to secure the best possible commercial advantage. The principle is that teamwork is better than combat. If the end-customer is to be best served then the parties to a deal must work together and both must win. Partnership sourcing works because both parties have an interest in each other's successes* (Partnership Sourcing Ltd. 1991:2 cited in Paul 1996)

However, when this definition of partnership is examined it makes it very clear that such partnerships are two-way, mutually win-win scenarios, rather than the imposition of requirements through guidelines or supplier criteria. As Paul (1996) notes the critical success factors in partnerships in the supply chain are the amount and freedom of information flow, teamwork of committed parties on both sides, and attention to detail during the matching, vetting and courtship stages of partnering.

Yet, it must be questioned if a partnership is an equally beneficially arrangement in a 'green' supply chain. If the customer 'requesting' changes in products or processes is the most powerful member of that supply chain, and the other supplier is dependent upon their custom it might be questioned whether any partnership between the two is mutually beneficial[9].

Another aspect of green supply chain partnerships is the coaching and mentoring role that can be taken by 'larger' organisations, industry bodies or green business groups. Berger *et al.* (2001) discusses the case of a project

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9 The influence of 'power' is examined in this study through the statistical tests in chapters 7-10, examining the critical dependency on customers and suppliers. An examination of these measures of 'power' (i.e. dependency) is presented in chapter 6.

on *'Environmental Partnering Action for SMEs in Supply Chains'* in South Wales. An *'Environmental Supply Chain Management Network'* has been established to bring together large manufacturing firms in the region to exchange information and share best practices on environmental supply chain management. In addition, there is a collaboration programme with large companies within a mentoring programme, to bring about a partnership approach to working with lower tier suppliers.

Gascoigne (2002) details a similar project which aims to help organisations improve environmental performance. Project Acorn, which is currently being piloted, involves a five level approach to implementing an environmental management system. This project aims to bring together large organisations with their suppliers to develop mutually beneficially environmental management programmes. The supplier-mentor relationship is identified as a key element in the possible success of Project Acorn.

Holt *et al.* (2000) discusses the use of coaching schemes, green business clubs and other facilitators of environmental change for SMEs and identifies a series of criticisms and issues that need to be addressed if they are to be effective. It could be argued that the key questions surrounding the use of such partnering schemes revolve around: whether such schemes monitor actual change rather than aspirational dialogue; whether they assess prior work being undertaken elsewhere; the tension between developing generic programmes suitable for a wider audience that are perceived to be less applicable to individual sectors; and whether such schemes are targeting appropriate organisations.

Baylis *et al.* (1998b) discuss the implications of green purchasing within SMEs and note it may be possible for SMEs to make internal environmental management changes, but that few large companies will entertain making changes to accommodate the requirements of SME customers or suppliers, which again relates to the issue of 'power' in the supply chain. This is a view echoed by Hill (1997) who notes that the balance of power between suppliers and customers is such that suppliers (especially SMEs) are less persuasive in the greener purchasing process. The location of an organisation within a supply chain is important, complex and rarely linear. Baylis *et al.* (1998b) note that the assumption that a SME is below a larger firm in the supply chain may be an erroneous one. This has implications for the success of the 'trickle down' effect of green supply chain management discussed with reference to the green multiplier effect in section 2.2.6.

Robinson (1991) examines the introduction of TQM requirements for suppliers and the effect of this upon the relationship between SMEs and large companies. Robinson found that close customer-supplier relationships led to a trend towards fewer suppliers. This appeared to be due to the perceived benefit of single sourcing, inability of the supplier to meet vendor certification and increased management time invested in suppliers. The introduction of TQM and environmental management have many parallels, not least in the concern by some companies that they would lose customers due to lack of accreditation to an environmental management standard as they had with TQM (Holt 1998). The trend discussed by Robinson (1991) for closer customer-supplier relationships leading towards fewer suppliers is also apparent when examining environmental management programmes rather than TQM (Caddick and Dale 1997). Nortel reduced their supplier base after a green supply chain programme was initiated stating that '*many of the small to medium businesses fail or are unwilling to meet the growing demand for demonstrable environmental probity* (BiE 1997:9)'.

Noci (1997) notes that companies such as Fiat, BMW and IBM have involved suppliers in their new product development processes by establishing relationships and implementing strategies based upon **single** sourcing (Gupta 1995), concentrating resources into a smaller number of suppliers. As Paul (1996) notes, by taking care during the selection and development stages of partnering, duplication of effort with other potential suppliers is wasteful and such a partnering approach therefore usually exists alongside a reduced supplier base.

2.2.5.3 Main Themes

Sections 2.2.5.1 and 2.2.5.2 suggest that there are two main approaches to the management of suppliers through green purchasing, firstly supplier assessment and selection, involving a range of supplier 'questionnaires' or models. Secondly, an approach that reaches out to suppliers to assist their improvements in environmental performance through supplier education, coaching and mentoring.

The success of supplier assessment and education programmes may be influenced by the 'channel power' of customers and suppliers (after Hall 2000, 2001). The relative 'power' of the key instigator of a green supply chain management programme may then affect whether green supply chain management 'trickles' down through the supply chain as part of a 'green multiplier' effect.

2.2.6 The Green Multiplier effect - Using Green Purchasing to Improve Environmental Performance beyond first tier suppliers

It could be argued that one of the primary aims of any green supply 'vendor management' programme is to cascade environmentalism through the supply chain with Lamming and Hampson (1996:S46) stating

> *'that it appears that diffusing environmental management techniques backwards or forwards through the supply chain might be a very effective way of developing the general environmental performance of an industry'*

The role of the influence of customers beyond the first tier is also discussed by Green *et al* (1996:190) who state:

> *'The idea of green supply is important because most purchasing decisions are to do with inter-corporate trade; commercial buying dwarfs consumer spending. If industry is seen as a complex web of buying and selling then the opportunities for environmental considerations to be brought into play are much greater than they are for individual consumer. In the green supply paradigm each stage has to consider not just the pressure which may be exerted by the immediate customer but the likely* ***pressures from the customers' customers and so on****. Firms that behave proactively on environmental issues might be able to reap*

advantage by foreseeing opportunities and problems throughout the whole chain. The emergence of green supply is therefore is important because it provides a more powerful mechanism for the so-called 'greening of industry' to be grounded in non-altruistic market principles'

However, it is hard to establish examples of a cascade of green supply chain practices from a customer to a first tier supplier and then subsequently to a second tier supplier, although there are anecdotal reports of a B&Q supplier sending out questionnaires to its own suppliers after a B&Q audit (ENDS[10] 1993). Hutchinson (1998) also makes reference to the B&Q example to highlight the difficulty of extending supplier auditing past the first tier, quoting the comments of a B&Q employee on tracing a paint brush back to its forest of origin.

'..he bought his paintbrushes from a company in Germany, who bought the timber from ..Italy, who bought it from a company in America, who bought it from a range of sawmills, who bought it from an even wider range of forests. So it was essentially a bit of a nightmare' (cited in Barrett and Murphy 1995).

There is little evidence, except anecdotally, of green supply chain management cascading values and standards across an extended supply chain. When a particular product specification changes then there are alterations in the composition and structure to reflect this (for example the case study by Hass (1996) of a hosiery manufacturer). Preuss (2001) examines this idea of a 'green multiplier' effect moving along the supply chain, across the boundaries between supplier and customer, but also along the whole of the supply chain. Preuss (2001) found no evidence of a green multiplier effect amongst a sample of 30 Scottish manufacturers. Therefore, evidence of the use of green supply chain management to cascade environmental behaviour beyond the first tier of customers and suppliers is scant and needs further investigation in a systematic manner[11].

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[10] ENDS – Monthly report published by the Environmental Data Services

[11] Appendix 12 presents an examination of the green multiplier effect amongst the respondents in this study (Holt 2004)

2.2.7 Summary

Therefore as part of a process of green purchasing and supplier management a firm may:

- Seek information on environmental aspects of policies, processes and systems from suppliers (Hill 1997; Green *et al.* 1998)
- Impose specific requirements upon suppliers (BiE 1997; Hill 1997)
- Address their own accreditation to an environmental management standard by assessing a supplier's environmental performance (Clayton and Rotheroe 1997; Baylis *et al.* 1998b)
- Cease to purchase from supplier who fails to meet criteria set (Baylis *et al.* 1998b; Knight 1995; Clayton and Rotheroe 1997)
- Cease to purchase from suppliers who fail to provide information requested (Baylis *et al.* 1998b)
- Undertake a 'coaching' programme to share experiences and best practice with their suppliers (BiE 1993, 1997).

2.3 Downstream Steering – Green and Reverse Logistics

Chapter 1 notes that green logistics is one aspect of the wider concept of green supply chain management. In this section a literature review of green logistics is presented.

2.3.1 Green Logistics

Logistics is defined by the Council of Logistics (cited in Taylor 1997) as

> '*the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in process inventory, finished goods and related information from point-of origin to point of final consumption for the purpose of conforming to customer requirements*'.

Taylor (1997) states that when logistics is examined from a holistic perspective as defined above, it is effectively synonymous with the definition of supply chain management. It is this wider, holistic, definition of logistics as defined by Taylor (1997) that is used in the context of this study. Daskin

(1985) argues that the traditional logistics 'discipline' does not include environmental issues, as it only focuses on the need to minimise costs and maximise profits. Increasing environmental legislation, associated with logistical issues such as packaging, product takeback and transport have moved environmental issues squarely into the mainstream of *'traditional'* logistics.

Poist (1986) defines different 'eras' in the development of logistics in organisations and states that logistics is currently in the *'Neologistics'* era, which is characterised by a total enterprise and responsibility approach (after Poist 1989). This approach is characterised by inter-functional and societal trade offs that look beyond the logistics function and economic implications, but are constrained by a high level of difficulty in implementing this wider remit. According to Poist, logistics can offer potential solutions to a variety of social issues and problems and is especially well positioned to contribute to environmental and ecological control in terms of packaging issues, pollution control and eco-efficiency and this is a view supported by Murphy *et al.* (1994, 1995, and 1996).

Section 1.2 introduces 'green logistics' as reviewed by Jolly and Charter (1992) who argue that the logistics function is highly visible, and likely to be scrutinised from an environmental perspective. Short and long-term green logistics strategies (Jolly and Charter 1992) are detailed in Table 2.4.

Table 2.4 : Greener logistics strategies (Jolly and Charter 1992)

Short Term Greener Logistics Strategy	Longer Term Greener Logistics Strategy
Carry out environmental audit of all activities Use life LCA to determine environmental impacts of logistics strategy Develop a programme to monitor and review environmental performance Develop links with local community for feedback on environmental and social issues Produce a balance sheet for materials and energy used in the logistics function	Carry out an environmental impact assessment (EIA) on all future developments Adapt logistics to land use policies aimed at reducing the need for transport Lobby vehicle manufacturers to prioritise improved vehicle efficiency Develop an awareness of likely changes in legislation and plan proactively Develop an awareness of likely developments in the transport network

Therefore, green logistics involves the incorporation of environmental issues into decision-making associated with the traditional logistics functions of packaging, transportation, and materials recovery through product takeback and recycling. Jolly and Charter (1992) indicates immediate management practices that can be adapted to green logistics in the short term, and management practices that require a more advanced, long term, strategic focus such as lobbying vehicle manufacturers.

Muller (1991) also examines case examples and quotations from a range of US companies concerning green logistics, with a particular emphasis on the management of wastes through pallets and packaging. Packaging and its environmental impacts are an important element of a green logistics programme and subject to increasing amounts of legislation and commercial pressures (as evidenced by the EU Packaging Directive). From a logistics perspective, packaging allows a product to be contained, apportioned, utilised and information to be communicated to customers (Prendergast 1995). Yet, the cases illustrated by Muller (1991) and many others (detailed in appendix 3) are examples of how packaging waste has become an increasing focus for environmental improvements efforts.

Most of the research on green logistics focuses on packaging and transportation. Authors such as Carter and Ellram (1998), Council of Logistics (1991), Davis (1996), Kopicki *et al* (1993) and Stock (1992) all identify the role of product takeback issues (reverse logistics) as part of green logistics management practices. Murphy and Poist (2000) note that though there has been a burgeoning body of literature involving environmental issues in other business disciplines, the corresponding literature on green logistics is characterised as '*small but expanding*'. The summary of over 100 influential papers and books used in this study (presented in appendix 1) identifies 15 general green logistics studies and a further 18 focussing on reverse logistics. However, only seven use empirical survey research instruments and are mostly from the suite of 'Murphy' studies (Murphy *et al.* 1994, 1995, 1996; Murphy and Poist 2000, 2003), along with Livingstone and Sparks (1994) and Prendergast and Pitt (1996). Section 1.3 identifies that the majority of the studies in appendix 1.1 are biased towards anecdotal research, lacking a wider supply chain focus on purchasing and logistics, and/or are sectorally or geographically biased.

2.3.2 Reverse Logistics, Re-use and Re-manufacture

Reverse logistics is a specific element of green logistics management activities, and is defined by Kopicki *et al.* (1993) as

> '*encompassing the logistics management skills and activities involved in reducing, managing and disposing of wastes. It includes reverse distribution, which is the process by which a company collects its used, damaged, or outdated products or packaging from end users*' (after Council of Logistics 1991).

Carter and Ellram (1998) build upon the definitions presented by Kopicki *et al* (1993) and Council of Logistics (1991), broadening the 'narrow' definition of reverse logistics as the reverse distribution of materials among channel members, to a more holistic view that it is the reduction of materials in the forward system in such a way that fewer materials flow back, reuse of materials is possible and recycling is facilitated.

Reverse logistics is the management of the reverse flow of materials but it is based upon the principals of waste minimisation as discussed in appendix 2. In the waste management hierarchy the process of materials reduction is the most desirable method of waste management. This involves the reduction of consumed materials and wastes through eco-efficiency measures and product design. The second option in a waste management hierarchy is that of 'reuse', whereby materials/energy are reused without transformation in the production process, either during the intra-organisational circling of material or interfirm cycling through product takeback. In the recovery option, material and/or energy is recovered using recycling, composting or 'waste to energy' power plants. Thus, from the Council of Logistics (1991) definition of reverse logistics, it is the return of materials to channel members and includes reuse or recycling of materials to original suppliers, as part of a wider process of green logistics. Whilst, in the holistic definition explored by Carter and Ellram

(1998), reverse logistics includes the management of the reverse flow of materials, but could include recycling or materials to organisations outside the original supply chain as well as waste exchange, and the re-use of waste products as raw materials in another production process, as strategic options within a wider green logistics strategy. Reduction of waste materials used in an organisation is part of internal environmental management practices, but may be based on life cycle assessment which Jolly and Charter (1992) identify as part of a long term green logistics strategy[12].

Kopicki *et al* (1993) in the study of a range of reuse and recycling programmes identifies four main elements that could benefit from the expertise of the logistics discipline. Firstly, adapting inbound supply chains to use recovered materials. Secondly, reuse and recycling programmes for packaging in the forward distribution system. Thirdly, in the area of product take-back and finally in creating third party services to facilitate recovery of materials within the operations function. Van Hoek (1999) notes how reversed flow can take many forms from collection of reversed shipments into the distribution channel for disassembly and reuse, through to recycling of raw material[13].

It is the wider, more holistic definition of reverse logistics that will be adopted for this study whereby reverse logistics is the:

> *'reduction of materials in the forward system in such a way that fewer materials flow back, reuse of materials is possible and recycling facilitated leading to the management of the reverse flow of materials along the supply chain or into the value chain of another organisation' (after Carter and Ellram 1998).*

Therefore, questions in the research instrument examine eco-efficiency, recycling and re-use of materials.

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12 Life cycle assessment is discussed in more detail in appendix 2. It includes assessment of transportation decisions that falls under the auspices of green logistics activities.

13 These flows of material through the supply chain are detailed in Figure 3.1

2.3.2.1 Case examples of reverse logistics

There are proven examples of logistics strategies (especially reverse logistics) contributing to improved financial and environmental performance of firms. Minahan (1998) suggest that the efficient management of returns can reduce annual logistics costs by as much as 10%. Examples of reverse logistics include the case study of Ametek who developed an integrated programme for collecting and recycling the foam cushioning used by its customer (Ethan Allen), cited in Ottmann (1998). Amtek pays Ethan Allen 10 cents per pound of material shipped back for recycling using the UPS Authorised Return Service (which was developed in 1990 for Canon's toner cartridge retrieval programme). This form of reverse logistics reduced their used-packaging volume by 85% and haulage costs for Ethan Allen by 70% after it was instigated (Ethan Allen 1993). Ottman (1998) suggests that this process in the first year alone diverted 10,000 pounds of used polypropylene foam from landfills. In addition, Amtek has strengthened its ties to its customers, whilst providing themselves with a reliable source of clean used material for recycling into their product (Forcini 1993). Tsoulfas *et al.* (2002) also note the important influence of close links with customers, suggesting that this improves the effectiveness of reverse logistics activities in the areas of recovery of batteries, glass bottles and printer cartridges.

In 1990 Canon began the Clean Earth Campaign, which donated $1 to the National Wildlife Federation and Nature Conservancy Council for every Canon toner cartridge returned to the company. In five years this resulted in the recycling of several million cartridges (reported in Ottman 1998). AT&T saved $100 million in the 19 months it operated a reverse logistics programme for it's telephone switching equipment (Dambach and Allenby 1995; Stock 1998) and British Telecom recovers 2.5 million telephones for reuse each year (Mayers *et al.* 1999). Schroeder produce refillable milk containers returned to the SuperAmerica chain of stores, which can be refilled 30-40 times and then recycled into lawn furniture and other products (Ottman 1998). BiE (1997) report how European suppliers of Nissan are required to use the returnable packaging developed by Nissan (also used for imported components from

Japan), with 95% of components arriving in returnable packaging and producing an annual saving of £95,500 from start up costs of £127,800. Lund (1996) identified over 70,000 remanufacturing firms in the USA, dealing in products in more than 47 different areas[14] [15].

2.3.2.2 The influence of legislation and sector

Environmental legislation is increasingly focussing on product takeback issues (Anderson et *al.* 1999; Cairncross 1992; Davis 1998; Nagel and Meyer 1999 and Stock 1992), namely the EU Electronics and Packaging Directives. However, such legislation focuses on specific product lines or packaging. Most general product takeback initiatives are voluntary and company dependent, and as such normally part of a competitive strategy (such as Kodak's returnable cameras that recycled 312 million cameras by 1999[16]). Bammert and Haßler (2001) survey the current status of environmental management practices during the manufacture of home electronics. None of the companies in their survey have full product takeback guarantees. Activity is mainly driven by legal requirements with voluntary agreements limited to certain geographical areas. Bammert and Haßler (2002:28) state that the concept of extended producer responsibility aimed at putting financial responsibility on producers to set up collection, recycling and disposal systems does not yet seem to be gaining ground.

Stock (1992) notes life cycle issues (a fundamental element of product takeback) are also a necessary element of the purchasing and procurement process. Thus, green logistics and green purchasing are inextricably intertwined. The process of reverse logistics will only be successful if the design and composition of the product is suitable and this suitability is ensured by the procurement function. Carter *et al.* (1998) notes the example of Mercedes who work in cross-functional teams to determine the environmental consequences of their components throughout the whole of the

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[14] www.reman.lit.edu/reference.timeline.asp
[15] The examples presented above are detailed along with others in appendix 3.

life cycle, and use the results of these analyses to inform the purchasing function. In the company 'General Mills' the purchasing function developed recycling centres and a reverse distribution infrastructure, to supply packaging and container supplies (Carter *et al.* 1998).

Reverse logistics activities are highly industry specific (Autry *et al.* 2001), with the development of life cycle product responsibility and assessment at different levels of development depending on the individual industrial sector in which developments take place. In 1993, CEST noted that a strategic approach to car disposal was already on the agenda in automotive manufacturers. Yet CEST described the strategies for disposal of electronics and electrical equipment as *'relatively embryonic'* (cited in Rodgers 1995). However, this situation has changed with the recent EU electronic directive on recovering value from end of life electronic and electrical equipment and end of life vehicles. Nagel and Meyer (1999) characterise end-of-life networks and note that as of 1999 Sweden, Switzerland, Netherlands, Norway, Austria Denmark and Germany all had legislation or draft legislation on product takeback. Davis (1996) identifies case examples of product take back schemes around the world. Mayers *et al.* (1999) examine the development of producer responsibility in the electronics sector (which is subject to an increasing amount of European legislation concerning product take back requirements). Meyers *et al.* (1999) estimate that the cost of collecting and recycling the 12 million items of end-of-life electrical and electronic equipment produced in 1991 to be £100 million in the UK alone. Therefore, reverse logistics, especially of consumer goods, has significant financial implications for organisations.

2.3.2.3 Re-manufacturing

Sarkis and Rasheed (1995) present a discussion paper on aspects of greening the manufacturing function through environmentally conscious manufacturing (ECM). A major element of ECM is the design of products that

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[16] www.reman.lit.edu/reference.timeline.asp

can be remanufactured or reused, and that have reduced consumption of raw materials during the manufacturing phase. The criteria that appear to distinguish products that are more likely to be remanufactured are detailed below (Sarkis and Rasheed 1995):

- Product technology is stable;
- Process technology is stable;
- Product is one that fails functionally rather than by dissolution or dissipation;
- The product has a core that is capable of being dismantled and restored to its original condition;
- The product is one that is factory built rather than field assembled; and
- The recoverable value added in the core is high relative to both market value and its original cost.

The demand for remanufactured products is a key issue for remanufacturers but optimal solutions are also dependent upon having suitable numbers of cores to remanufacture. Therefore, as Jayaraman *et al.* (1999) note managers must ensure availability through co-operative leasing agreements or economic penalties for disposal of returnable goods. Therefore, arguably remanufacturing is effectively dependent upon successful reverse logistics flows and increasing research is now focussing on quantitative logistical models (for examples see Fleischmann *et al.* 1997, 2000).

2.4 Green Supply

Sections 2.2 and 2.3 identify the inherent links between green purchasing and green logistics, yet section 1.3.3 notes that the majority of prior survey-based research studies do not examine simultaneously both the upstream and downstream management practices in organisations. A number of theory building studies (such as van Hoek 1999; Wu and Dunn 1995) consider holistic green supply chain management practices that examine both purchasing and logistics. Green supply chain management is introduced in section 1.2 and is described by Green *et al.* (1996) as resulting from:

....the fusion of increased awareness of the strategic importance of purchasing, the new focus on co-operative buyer-seller relationships and the awareness of the connection between purchasing and logistics decisions, on environmental performance.

Table 2.5 describes a range of green supply chain management operational practices that includes purchasing and logistics activities

Table 2.5: Green supply chain management practices (adapted from Melnyk and Handfield 1996)

Materials Function	Proactive	Reactive
Supplier Selection and Evaluation	Disclose and label composition; supplier selection on environmental grounds; reusable packaging; sustainable resource management; and risk assessment	Environmental issues not part of selection procedure; dispose of packaging; and sole reliance on regulatory requirements
Surplus and Scrap Disposition	Analysis of materials impacts prior to use in new products; reclamation of materials; and consideration of waste management hierarchy options during all stages of product life cycle	After the fact remedial action; lack of duty of care; and lack of assessment of waste hierarchy options
Carrier Selection and Transportation of Materials	Environmental audits of high risk carriers; extra protection for high risk materials; low emission vehicles; route scheduling to reduce congestion times; and back load carriers for returned materials	Relatively little attention paid to carriers except when a spill occurs
Product Design, Packaging and Labelling	Cradle to grave LCA used to redesign or develop eco-designs; remanufacture; standardised reusable containers; packaging assessed and redesigned; and labels used on products to assist recycling	End of life strategies not part of design procedure; products landfilled at end-of-life; no recycling; non-reusable containers; and no labelling of parts for recycling

Canner and Hanmer-Lloyd (2001:227) identify four groups of green supply chain activities that include both upstream and downstream operational activities.

- Provision of information of environmentally damaging substances and company environmental strategies and improvements, to customer organisations (Schot 1992; Cramer and Schot 1993; Green *et al.* 1996; Walton *et al.* 1998).
- Changes to product and packaging designs as consequence of the

banning of hazardous substances and growing demand for recycled materials, components and complete products (Cramer and Schot 1993; Florida 1996; Walton *et al.* 1998).

- Development of reverse-flow logistics systems to accommodate legislative and consumer demand for packaging and product takeback (Thierry *et al.* 1995; Walton *et al.* 1998).
- Development of R&D programmes between suppliers and customer companies (Schot 1992).

A benchmarking study of 20 large US companies with *leading* green supply chain management practices share nine common characteristics (BSREF[17] 1997; Lippmann 1999, 2001). These are:

1. Strong high level commitment to environmental stewardship;
2. A desire to lead industry efforts to improve the environmental performance of suppliers;
3. Integration of environmental goals/aims and staff members, into core business functions involving suppliers;
4. Clear consistent and frequent internal communication on environmental issues and the value of good environmental performance to the company;
5. Clear consistent and frequent two-way communication about environmental issues with suppliers;
6. Targeted supplier effort;
7. Supplier solicitation, selection and monitoring processes that incorporate environmental performance;
8. Ongoing supplier education; and
9. Feedback mechanisms to improve suppliers' environmental management programmes.

Gavaghan *et al.* (1998) also reviews the BSREF study on benchmarking *'leading edge'* US companies' green supply chain management activities. Their extensive supplier management programmes all share similar characteristics of high level corporate commitment, top level support, cross functional integration, effective communication criteria and effective processes for targeting, evaluating, selecting and working with suppliers. They also expand on the common traits of these leading edge companies as detailed below:

- the participants had some form of environmental criteria to screen suppliers. Considered environmental performance when considering whether to continue to work with suppliers;
- believed their actions have benefited suppliers (although there was no quantitative data to support this);
- stakeholders were also interviewed to identify their expectations of green supply chain management programmes;
- stakeholders expected companies to achieve at least a minimum environmental compliance. The most progressive stakeholder groups expected leadership companies to go beyond compliance. A few stakeholder groups have also begun to formally incorporate environmental criteria into the assessment of companies' environmental performance; and
- all the stakeholder groups in this study expressed an interest in working with companies and have frequent and influential communications with customers and a wider audience.

The nine principles and common traits identified in the BSREF study form the basis of the 'advanced' green supply chain management practices investigated in this study.

2.5 Influential Research Studies on Aspects of Green Supply Chain Management

Key research studies on one or more aspects of green supply chain management are summarised in table 2.6. These works are grouped into one of four methodological approaches: survey, case study, simulation/modelling or secondary based theory-building approaches. Empirical, questionnaire

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[17] Business for Social Responsibility Educational Fund

based research involves quantitative and qualitative data collection, either by mail or web based surveys. Case study based research involves data that is collected and analysed from content analysis of public documents on organisations, or collected during open, semi-structured and telephone interviews and discussions. In theory, building research secondary data sources are used to synthesise previous work in a particular area and develop new theories without empirical testing, or the collection of primary data. Simulation or quantitative models build scenarios for green supply using real or dummy numerical data to model aspects of green supply chain management, such as recovery networks. Simulation/modelling papers in this discussion are quantitative models that simulate aspects of green supply chain management. Other types of models presented in the secondary based theory building papers, are mainly process and theory based models.

Table 2.6: Methodological approaches in previous green supply chain management research

Empirical Questionnaire Based Research	**Case Based Research (Interviews, case investigation)**
Autry *et al.*, 2001; Baylis *et al.*, 1998b; Bowen *et al.*, 2001; Carter and Carter, 1998; Carter and Carter, 2000; Carter and Jennings, 2001; Carter *et al.*, 1998; Florida, 1996; Hill, 1997; Holt, 1998; Klassen and Whybark, 1999; Livingstone and Sparks, 1994; Min and Gale, 1997; Murphy and Poist, 2000; Murphy *et al.* 1994, 1995, 1996; Prendergast and Pitt, 1996; Roa, 2002; Roberts, 1996; Strong, 1992; Theyel, 2001; Young and Kiekliewiez-Young, 2001; Ytterhus *et al.*, 1999; Zsidisin and Hendrick, 1998	Anderson *et al..*, 1999; Berger *et al.*, 2001; Canning and Hanmer-Lloyd, 1998; Davis, 1998; De Bakker, 2002; Drumwright, 1994; Elwood and Case, 2001; Ennarson, 1998; Gavaghan *et al.* 1998; Geffen and Rothenberg, 2000; Green *et al.*, 1996; Green *et al.*, 1998; Hagekaar *et al.* 2002; Hall, 2000; Hall, 2001; Halme, 1995; Hass, 1996; Jahre, 1995, Johnson, 1998; Kiopicki *et al.*, 1993; Lamming and Hampson, 1996; Lippman, 1999; New *et al.*, 1999; New *et al.*, 2002; Pohlen and Faris, 1992; Polonsky *et al.*, 1998, Preuss, 2001; Stock *et al.*, 1992; Walton *et al.*, 1998; Young and Kiekliewiez-Young, 2001
Modelling and Simulation	**Theory Building**
Barros *et al.*, 1998; Faruk *et al.*, 2002; Fleischmann *et al.*, 2000; Jayaraman *et al.*, 1999; Khoo *et al.*, 2001; Klausner *et al.*, 1998; Krikke *et al.*, 1999; Kroon and Vrijens (1994); Nagel (2003); Nagel and Meyer (1999); Noci, 1997; Sarkis, 1998.	Beamon, 1999; Boons, 2002; Cairncross, 1992; Carter and Ellram, 1998; Green *et al.*, 2000; Gungor and Gupta, 1999; Hart, 1995; Klassen and McLaughlin, 1996; Lamming *et al.*, 1999; Rodrique *et al.*, 2001; Rogers, 1995; Sarkis and Rasheed, 1995; Van Hoek, 1999; Wolters *et al.*, 1997, Zsidisin and Siferd, 2001.

The literature review presented in this chapter examines aspects of green supply chain management in theory and practice. A critique of previous studies that use empirical, survey based research instruments is presented in chapter 1 (section 1.3). An analysis of the most influential prior research studies is also presented in appendix 1.1 and the key research gaps identified by these studies is presented in appendix 1.2.

The review of the literature presented in this chapter supports the general criticism of previous studies: that they fail to take a whole supply chain approach; are mostly anecdotal; and geographically and sectorally biased. There is undeniably a large amount of existing work on aspects of green supply chain management, such as green purchasing and to a lesser extent green logistics. However, much of this previous work is anecdotal or theory building, without empirical testing and validation. The empirical work that is identified in table 2.6 mostly focuses on one aspect of green supply chain management (such as purchasing or logistics) and is limited to a restricted sectoral sample.

The main contributions of this literature review to the thesis are:

- An overview of operational practices in green logistics and green purchasing;
- Questions surrounding the effectiveness of the green supply chain management to cascade environmentalism through the supply chain (the green multiplier effect);
- The role of 'channel power' of an individual organisation and how this may affect the diffusion of green supply; and
- A synthesis of existing literature on green purchasing, green logistics, reverse logistics and green supply.

The next chapter presents the development of the green supply chain pressure / response model of green supply that forms the basis of this study.

CHAPTER 3: DEVELOPMENT OF THE GREEN SUPPLY CHAIN MANAGEMENT PRESSURE/ RESPONSE MODEL

3.1 Introduction

The purpose of this chapter is to develop a pressure/response model of green supply chain management. This chapter builds on the literature review presented in chapter 2 to examine objectives 1 and examines the secondary cases in appendix 3 to examine objective 2 (as identified in section 1.4.1).

Objective 1: To review the theoretical basis of green supply chain management from a holistic perspective, incorporating an upstream and downstream approach by examining green purchasing (including supplier management), internal environmental operations management, strategic environmental policies and green logistics.

Objective 2: To identify and model, through analysis of secondary case examples, the operational framework of green supply change management and the factors in the macro environment that may influence the type and level of operational response.

The overall aim of this study is to develop and statistically test an exploratory model of the pressures driving green supply chain management and resultant operational practices. Therefore, this chapter focuses on the two aspects of the model: the possible drivers, and possible green supply chain management practices. Later statistical analysis presented in chapter 10 examines whether there are specific relationships between the drivers and management responses within this model.

The previous chapter reviewed green supply chain management and identified that there are management practices associated with different aspects of green supply chain management. Chapter 2 established that there are upstream activities associated with **supplier assessment and evaluation** (section 2.2.5.1), **supplier education and mentoring** (section 2.2.5.2) and **green logistics** (section 2.3). In addition, chapter 2 identifies that there are **internal environmental management** practices associated with eco-efficiency and product/process management, along with strategic environmental considerations incorporated into internal **environmental policy** instruments (both of these aspects are presented in greater detail in appendix 2). The discussion of supplier education presented in section 2.2.5.2) suggests the need for 'outreach' activities as part of '**industrial networks'**.

Therefore green supply chain management practices might be clustered into six groupings:

- Environmental Policy (policies on green purchasing and green logistics);
- Process and product design and redesign (as part of internal environmental operations management);
- Supplier assessment, performance evaluation and selection strategies;
- Supplier education, mentoring, coaching and dissemination of best practice;
- Green Logistics programmes (including reverse logistics); and
- Development of industrial networks (waste exchange networks or industrial groups who share knowledge, best practice and provide support).

This chapter begins by confirming the possible management practices involved in green supply chain management, by using content analysis of the secondary, anecdotal case studies presented in appendix 3 (section 3.2). Then section 3.3 examines the possible drivers of green supply chain management, by reviewing the wider literature of drivers of environmental management. The literature review (chapter 2) and the literature on environmental management (discussed in synopsis form in Appendix 2) suggest a range of external (examined here in section 3.3.1) and internal drivers (section 3.3.2) of environmental management activity and green supply chain management[1]. Section 3.3.3 also examines possible barriers/ obstacles to green supply. Section 3.4 identifies possible relationships between all the elements of the green supply chain management model presented in the previous section, as well as the possible moderating influence of organisational contingencies (represented by the sample's demographic characteristics) upon this model.

3.2 Green Supply Chain Management Operational Activities

This section examines the possible management practices that may take place in an organisation as part of green supply chain management programme. A number of guidelines are available for companies seeking to include environmental issues in supply chain management (BiE 1993, 1997; Groundwork 1996; IEHI, 1996; Kiopicki *et al.* 1993; Stock 1998), which detail management practices organisations may undertake. Examples of these practices are examined in a range of specific organisations (as summarised in Appendix 3).

It is vitally important in this study for the reader to be able to visualise the flows of materials, information, values and standards that may occur in a green supply chain. Therefore, figure 3.1 details the generic flows of materials, values and standards that are associated with greening the supply chain as identified in the literature previously presented in chapter 2 and the secondary case examples examined in Appendix 3[2]. Figure 3.1 sets the context for the green supply chain management pressure/response model developed in this chapter. Green supply chain management involves the flow of materials, organisational values and required 'standards' through the supply chain. As discussed in section 1.3.3 few of the previous green supply

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[1] See also Holt (1998) that discusses some of the potential drivers/benefits of accreditation to the environmental management standard BS7750 in an exploratory sample of organisations.

[2] It is important to note that recycling has two forms. First, recovery of the product or material in its original form for use without alternation to its basic composition or structure in the same or different transformation process. Or secondly recycling might occur through a form of generic recycling where the raw material is recovered and used in a transformation process different to the one it was originally utilised in.

chain studies examine such flows across the supply chain, predominantly focussing on the reverse flow of materials (reverse logistics), flow of standards to a first tier supplier (supplier assessment), or information on general environmental values (through green policies or general green purchasing).

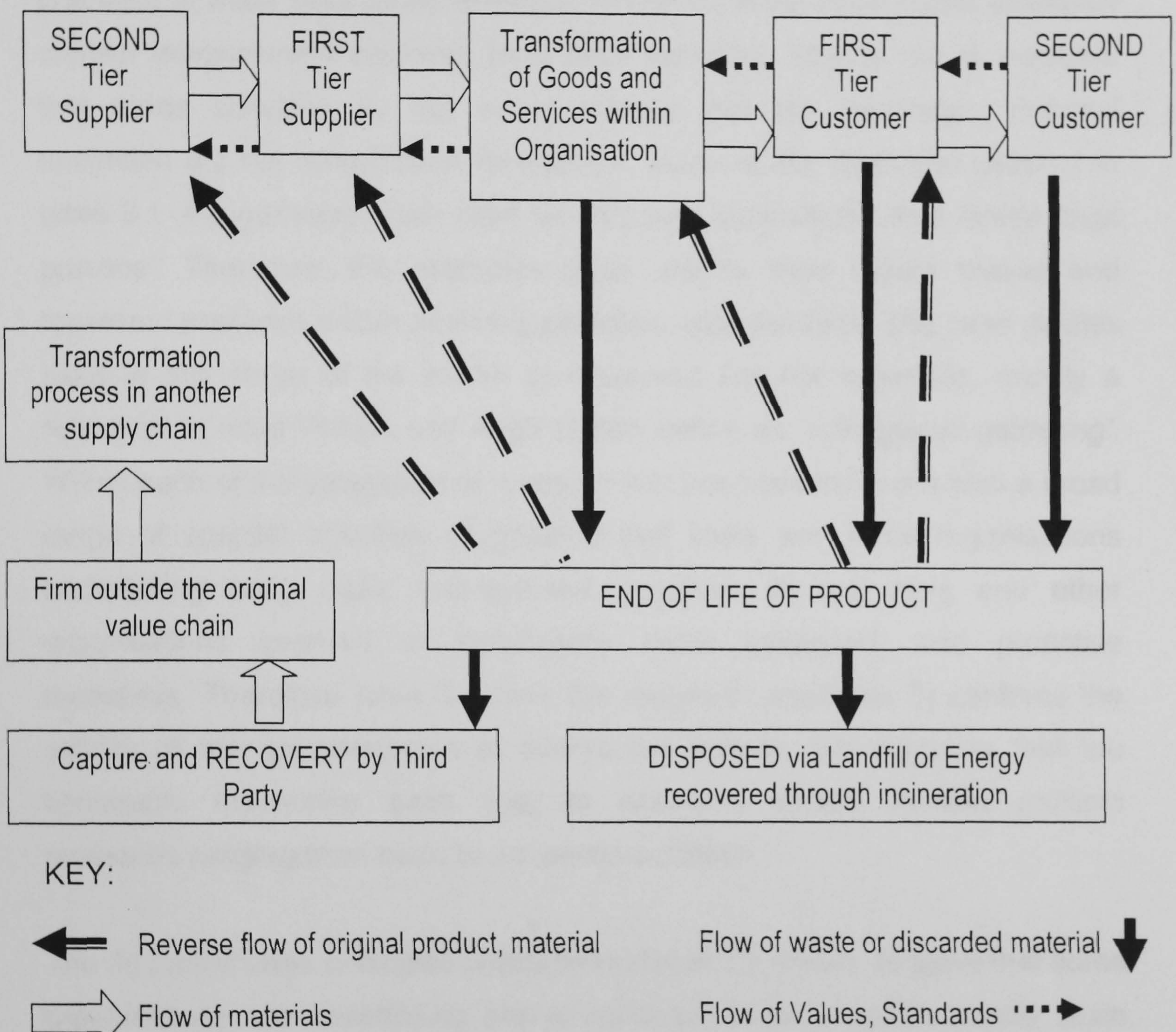

Figure 3.1: Generic Flows of materials, values and standards through the green supply chain

Although figure 3.1 identifies the flow of values and standards beyond the first tier of the supply chain, this study examines the green supply chain only as far as the influence of first tier suppliers and customers. Examination of the second tier level of the supply chain would require detailed case study work in specific industrial supply chains (for example Hall 2000, 2001).

3.2.1 Analysis of case examples of green supply chain management operational practices

The analysis of the cases in Appendix 3 (presented in summary in table 3.1) identifies *at least* one of the six categories of green supply chain management practices in each case study example. However, none of the case examples contain management practices from each category. This is not to presume that these activities do not occur, merely that the secondary material examined did not report them. In addition, many of the examples detailed in table 3.1 are gathered from case studies and publications that stress 'best practice'. Therefore, the examples given are by their nature biased and represent practices within relatively proactive organisations. The case studies used in this stage of the model development are not extensive, merely a reflection of what Philips and Pugh (2000) define as '*intelligence gathering*'. Within each of the categories of management practices there are also a broad range of specific activities, suggesting that there are some organisations undertaking fairly basic management practices in that area and other organisations involved in significantly more advanced, and proactive measures. Therefore table 3.1 (and the details in appendix 3) confirms the validity of the six categories of operational activity, but suggests that the constructs measuring each type of practices should contain multiple measures ranging from basic to advanced activities.

The 36 partial case examples presented in table 3.1 clearly suggest that some organisations are undertaking one or more elements of green supply chain management. However, the proliferation of anecdotal evidence, normally presented as part of a single case example, or empirical work that examines one of these elements in a specific industry, shows the clear need for the structured development of the green supply research agenda. It is important that the possible drivers of green supply chain management practices are examined to determine whether they influence the likelihood of certain management practices occurring.

Table 3.1: Analysis of green supply chain behaviour in selected case study examples (see Appendix 3).

X PRESENT IN CASE STUDY EXAMINED	Environmental Policy	Product / Process Design & Redesign	Supplier Assessment, Evaluation & Selection	Supplier Education, Coaching, Mentoring	Green Logistics (product, components or packaging)	Industrial networks
Advanced Micro Systems	X	X	X	X		X
Allergan	X	X	X	X		
Ametek		X			X	
AT &T					X	
B&Q	X		X	X		
Business & the Environment			X			
Corenso United						X
Crane & Co		X				X
Dell	X	X			X	
Dofasco		X			X	X
Eastman Kodak					X	
Herman Miller Inc					X	
Hewlett Packard		X	X		X	
IBM		X			X	
Intel			X			
J Sainsburys			X	X		
John Deere		X	X		X	
MCC		X			X	X
National Power	X		X	X	X	
Nissan UK		X		X	X	
Nortel	X	X	X	X		
Patagonia		X	X			
Pilkington			X	X		
R.Frazier		X				
Safety Kleen		X			X	
Safeway					X	
SC Johnson		X		X		
Schroeder					X	X
Shadow Lake		X				X
Shaw Industries		X	X	X	X	X
Shields Special Metals	X					X
Target Stores		X			X	X
United Utilities & NorthWest Water	X	X	X	X		
Wellman Inc		X			X	X
Xerox Corp	X	X	X	X	X	

3.3 Drivers of Green Supply Chain Management

As identified earlier the exploratory model of green supply chain management incorporates the pressures driving green supply and possible resultant management practices. These types of green supply chain management practices are presented in section 3.2. This section now reviews the literature on possible pressures/ drivers within green supply by examining the wider literature on drivers of environmental management. None of the previous quantitative green supply chain management studies presented in appendix 1.1 (and in summary in table 1. 1) comprehensively examine the drivers of upstream and downstream green supply chain operational activity, so it is necessary to examine this wider literature on environmental management. A distinction is also drawn in this section between pressures emerging from outside an organisation (external) and those that emerge from within it (internal).

The 1998 study by the Institute of Managers (table 3.2) identifies a range of potential external and internal pressures driving environmental activity, with regulation identified as the most influential driver of change, followed by consumer pressure and pressure from environmental pressure groups.

Table 3.2: Relative importance of drivers of environmental activity in organisations (IM 1998)

Driver of Change	*Relative Importance (%)*	*Driver of Change*	*Relative Importance (%)*
Legislation	48	Best Practice Development	18
Regulatory Requirements[3]	43	Community Relations	17
Consumer Opinion	35	Employee Pressure	11
Environmental pressure Groups	34	Corporate Values	11
Customer Requirements	22	Education System	10
Media	18	Competitive Pressure	9
Board/top management team	18		

[3] It is unclear in the IM (1998) study the differences between 'legislation' and 'regulatory requirements'. In this study, legislation and regulation are interchangeable terms and both refer

The IM (1998) study identifies a broad range of possible drivers of environmental activity in a wide cross-sectoral group of private sector organisations. However this study is not focussed on green supply chain management practices only, but those relating to broader environmental issues.

Table 3.3 summarises some of the previous studies that examine the pressures driving general environmental management or aspects of green supply.

Table 3.3: Previous studies that categorise environmental pressures

Author(s)	Types of Pressures	Focus of Research
Carter and Ellram (1998)	Driving Forces: Government, suppliers, buyers and competitors. Constraints: stakeholder commitment, top management support, incentive systems, vertical co-ordination and quality of inputs.	Categories of environmental forces that affect the implementation of reverse logistics
Elwood and Case (2000)	Responding to customer interests in environmentally friendly products; Distinguishing a company and its products from competitors; Pursuing cost savings; and Joining an industry trend.	Pressures driving environmental purchasing in private sector
Green *et al.* (1996)	Driving forces: legislative and regulatory compliance, minimisation of risk, identification of cost reduction, resource minimisation, pressure from investors, customer pressure and environmental management as part of a quality improvement process.	Examined environmental policies in 15 large companies in a range of sectors.
Lanoie and Tanguay (2000)	Key influences were the role of the US parent company which adopts a more proactive environmental stance, the role of decreasing costs, an environmental champion driving environmental management efforts, the role of environmental regulation to decrease effluents, recovery of waste materials and the role of head office in promoting new environmental ideas	Examined companies in Quebec and environmental management activities
Rondinelli and Berry (1998)	Regulatory demands, a stakeholder focus, cost factors and competitive factors	Drivers of production and environmental management

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to specific legislative requirements that organisation's feel are applicable to them.

Hall (2000:457) identifies a range of drivers of environmental management not directly linked to legislation: These are:

- customer pressure;
- consumer pressure;
- shareholders (pension/ mutual fund investors, credit rating agencies);
- environmental advocacy pressure groups (community groups, environmental groups and other stakeholders);
- accountability/ disclosure requirements;
- employees/ unions;
- green voters;
- corporate citizenship; and
- improving technologies.

Hall (2000:456) notes that *'firms' change their environmental performance in response to pressures from such sources as environmental advocacy groups, consumers, regulators and neighbours.'* However, not all firms are exposed to the same types of pressure or to the same extent, with larger higher profile firms typically experiencing the most pressure to change their environmental performance (Hall 2000: 2001).

Canning and Hanmer-Lloyd (2001) discuss a range of motivations leading to environmental adaptations, particularly in customer supplier relationships due to environmental reasons. The introduction of environmental legislation may change the behaviour of firms, such as the banning of CFCs, which leads to a search for alternative more benign alternatives. Another example is the EU Directives affecting the electronics industry, which require them to take-on board end of life responsibilities for their products (Davis 1996).

Henriques and Sadorsky (1999) identify four critical stakeholder groups that may influence an organisation to change its environmental behaviour:

- Regulatory stakeholders who either set standards or can convince governments to do so and including competitors who set industry norms;
- Organisational stakeholders, such as customers, suppliers, employees

and shareholders;

- Community groups, environmental organisations and other potential lobbyists; and
- The media who can influence public opinion.

These stakeholders may also exert differential pressures depending upon the sector or type/visibility of the organisation. The most important environmental stakeholders perceived by Norwegian and European companies are examined by Ytterhus *et al.* (1999). They found that in *service* firms and *wholesale/retailers* the most important stakeholders appeared to be owners. In the *service* sector the second most influential stakeholders were employees, followed by environmental regulators, local environmental initiatives, media and customers in descending order. Whereas, in the *wholesale/retailing* sector environmental regulators were the second most important stakeholders, followed by customers, media, employee and local environmental initiatives in descending order.

A number of studies examine the tangible and intangible benefits of environmental management (anecdotal examples are presented in the case examples detailed in Appendix 3). It might be argued that the benefits of environmental management are directly linked to the pressures that drive environmental management. Bowen *et al.* (2001a) presents a review of the benefits of green supply chain management and the prior research that identifies these benefits (as illustrated in Table 3.4).

Table 3.4: Potential benefits of green supply (Bowen *et al.* 2001a:43)

Measures of benefits from green supply	Cited in
Benefit to Society	
Aid diffusion of environmentally sound practices through industry	Bowen *et al.* 2001b; Green *et al.* 1996; Lamming and Hampson 1996; Russel 1998
Facilitate legislative compliance	Green *et al.* 1996; Hampson and Johnson 1996; Min and Galle, 1997
Reap greater environmental benefits through co-operation	Cramer 1996
Facilitate moves towards sustainability	Miller and Szekely 1995; Russel 1998
Eliminate or reduce demand for environmentally harmful raw materials	Epstein and Roy 1998; Min and Galle 1997
Encourage use of a life-cycle, holistic approach	Lamming and Hampson 1996; White 1996
Benefit to Firm	
Reduce Costs	Bowen *et al.* 2001b; Cramer 1996; Drumwright 1994; Green *et al.*, 1996; Russel 1998
Manage Reputation Risks	Bowen *et al.* 1998; Drumwright 1994
Manage liability for environmental damage	Min and Galle 1997
Avoid potential increase in cost of waste and waste disposal	Lamming and Hampson 1996; Min and Galle 1997
Deliver legislative compliance at lower cost (current and future)	Green *et al.* 1996; Hampson and Johnson 1996; Min and Galle 1997
Improve product or service quality	Cramer 1996; Noci 1997; Russel 1996
Meet market expectations	Hutchinson 1996; Knight 1996
Benefit to Purchasing and Supply Process	
Support corporate environmental objectives	Carter and Carter, 1998; Carter *et al.* 1998; Green *et al.* 1996; Hart 1995; Lamming and Hampson 1996; Noci 1997
Develop co-operative relationships with suppliers	Lamming and Hampson 1996; Noci 1997
Reduce direct costs associated with purchasing	Carter *et al.* 1998; Min and Galle 1997; Stock 1992; Russel 1998
Maintain security of supply	Lamming *et al.* 1996; Russel 1998
Improve Purchasing's status and or strategic importance	Bowen *et al.* 1998; Green *et al.* 1996

The reasons for establishing environmental policies in the companies examined by Murphy *et al.* (1995) are associated with complying with government regulation (84.2% of respondents), minimising environmental liability (63.2%) controlling environmental related costs (69.9%), responding to societal expectation (66.2%), providing profit opportunity (21.8%) and keeping up with competitors (15%), and these show similar trends to those reported in Rao (2002), and anecdotal findings of Holt (1998).

However, the results reported by Rao (indicated in table 3.5) reflect much higher values that those of Murphy *et al.* (1995). It is perhaps pertinent to consider that the Rao study is reporting on companies that are already very 'proactive', as they have accredited to an environmental management standard and this perhaps is reflected in these very high values.

Table 3.5: Benefits from accrediting to an environmental management standard amongst sample of companies in SE Asia (Rao 2002)

Specific Benefits	**% ***	**Specific Benefits**	**% ***
Improved corporate image	97	Productivity improvement	84
Environmental compliance improvement	94	Reduction of emissions	83
Increased efficiency	93	Recycling	77
Social commitment	90	New market opportunities	66
Reduction of solid/liquid waste	88	Market share	58
Preserve environment	86	Sales	54
Quality improvement	86	Profit margin	49
Cost saving	85	Product price increase	37

* Percentage of those that agreed and strongly agreed on 4 point scale.

Table 3.5 clearly identifies that there are perceived competitive advantage to this accreditation (after Walton *et al.* 1998). An anecdotal exploration of 13 UK companies that accredited to the environmental management standard BS7750 identified perceived benefits from this accreditation in the measurable attributes associated with water, waste and energy eco-efficiency. Some of the 13 companies reported benefits in less tangible outcomes, such as image and reputation (Holt 1998). The fact that the organisations in the Rao (2002) study chose voluntarily to accredit to this standard may also suggest that they have a much greater perceptional awareness of the potential benefits of a proactive environmental management programme.

The general discussion presented above details the possible benefits and drivers of environmental management activities, such as green purchasing (e.g. Carter and Carter 1998), accreditation to an environmental management standard (e.g. Holt 1998; Rao 2002), and general environmental management (e.g. IM 1998).

The discussion presented above (and specifically tables 3.2-3.5) suggests that previous studies all use subtly different specific measures of external and internal drivers. However, all of these measures might be grouped into five categories, as illustrated in table 3.6. The categories are:

- Internal
- Legislative;
- Competitive/ Financial;
- Societal; and
- Supply Chain.

Table 3.6: Examples of measures of the different types of benefits/ drivers

Reference	*Internal*	*Legislative*	*Competitive*	*Societal*	*Supply Chain*
IM 1998	Employee Pressure; Board/top management team; Corporate Values	Legislation; Regulatory Requirements;	Best Practice Development; Competitive Pressure	Community Relations; Environmental pressure Groups; Education System Media;	Consumer Opinion; Customer Requirements
Rao 2002		Environmental compliance improvement; Reduction of emissions	Improved corporate image; Increased efficiency; Productivity improvement; New market opportunities; Market share, Sales; Profit; margin Product price increase; Quality improvement; Cost saving; Recycling	Social commitment Preserve environment	
Murphy *et al.* (1995)		complying with government regulation; minimising environmental liability	controlling environmental related costs; providing profit opportunity; keeping up with competitors	responding to societal expectation	

Few of the studies identified in table 3.4 present quantitative data in the same manner of the studies by IM (1998) and Rao (2002). However, these quantitative studies presented in tables 3.2 and 3.5 suggests that different types of drivers have different relative levels of importance, for instance legislation is most frequently cited as the most influential driver (IM 1998; Murphy *et al.* 1995; Rao 2002). The next section examines firstly the four external drivers (section 3.3.1), and secondly the internal drivers (section 3.3.2).

3.3.1 External Drivers

An overview of general environmental pressures/drivers is presented in the previous section. The following discussion examines some of these individual types of pressure in more detail.

3.3.1.1 Legislative Pressures

Welford and Gouldson (1993:18) state that *'the development of legislation is singularly the most important factor influencing the* (environmental) *behaviour of industry'.* Lamming and Hampson (1996) discuss how elements of legislation affect environmental supply chain management, and that companies such as BMW (who set up environmental management programmes with partners) have potentially gained first mover advantages by pre-empting potential new environmental legislation. In their sample of manufacturing and processing companies in South Wales, Baylis *et al.* (1998b) report that 65% of the SMEs, and 86% of the larger companies identify compliance with legislation as a motivation for encouraging environmental improvements. Avoiding penalties associated with failing to comply with environmental legislation is the key driver in a sample of the top 400 grossing companies in the UK (Ghobadian *et al.* 2001).

Davis (1996) examines product takeback issues in the electronics sector around the world and identifies legislative drivers as the key influence in this sector. Preuss (2001) also identify the main driving force for environmental improvements in the electronics sector in Scottish manufacturers as legislation. Kroon and Vrijens (1994) examine the influence of legislation in Germany and the Netherlands associated with reducing packaging waste, and found many companies in their study using their supply chain to address this issue.

Geffen and Rothenberg (2000) discuss the role that environmental legislative pressure has in the USA automotive paint process. They note that 60% of General Motor's annual pollution prevention costs are involved in controlling air pollution emissions. This pressure seems to be leading this industry to closer collaborative partnerships with suppliers to develop new lower polluting materials. Although this is associated with economic pressures, this emerges from the legislative environment associated with highly polluting chemicals in 'dirtier' industries. Tilson (1999) also examines drivers for change in the automotive industry in the West Midlands (UK) and notes that legislation on emission, pollutants, recycling and waste disposal are all issues driving product changes in this industry.

For more than 20 years in Michigan State, beverage distributors and retailers have been mandated by legislation to collect empty beverage containers for recycling. Goldsby and Closs (2002) estimate that 60% of all beverage containers in 1997 were processed through reverse vending machines. This is an industry that has developed to fill the niche formed by the legislative requirements for recycling of beverage cans. A similar model is also in operation in Germany. In the US businesses whose sole business activity is reverse collection of recyclable materials are commonplace, especially in specific States that have stringent recycling and waste management legislation.

Groundwork (1996: 20) believe that legislation impacts green purchasing even more stringently in local authorities than it does in industry. In addition, local authorities have the added complication of operating under compulsory competitive tendering and EU purchasing directives.

This section identifies that environmental legislation is a key, and in many cases apparently the most influential, driver of environmental initiatives in organisations.

3.3.1.2 Competitive and Financial Factors

Although Krikke *et al.* (1999) state that legislation is the driving force behind the return of materials to Original Equipment Manufacturers (OEMs), the main goal of such initiatives is to exploit commercial opportunities. Economic recovery of assets is a key driver of environmental management in a range of product takeback schemes (Davis 1996), with the most valuable end of life products having a recovery/take back programme in place. Stock (1998) describes a series of reverse logistics supply chain initiatives in the USA that have led to cost savings.

- Toyota Motors saved $3.6 millions in 1990 by developing packaging standards for suppliers based on reusable and recyclable packaging.
- In 1996 Baxter's environmental initiatives saved the company $11 million.
- Herman Miller Inc. saved more than $1 million dollars by using reusable containers and cartonless furniture.
- In 1992, Deere and Company instituted a reusable packaging programme that resulted in savings of $1.7million and a reduction in inventory stock of 18%.

Elwood and Case (2000:77) discuss a range of examples of cost savings arising from environmental supply chain and operational initiatives. PSE&G saved more than $2 million by reducing its supplier base from 270 to 9 suppliers, which resulted in dramatically reduced costs for the wasted chemicals. Baylis *et al.* (1998b) identify increasing profit by reducing costs as a key incentive for improvements in environmental performance, with 51% of SMEs and 64% of large companies identifying this as an important driver in their environmental initiatives.

The previous examples all focus on how improvements in environmental performance potentially lead to internal cost savings, and thus improving competitive performance. Evidence seems to be emerging that improving environmental performance can lead to greater financial benefits from an external perspective. Feldman *et al.* (1997) argues that environmental improvements lead to higher stock prices. Plesse (1992) examines the influence of specific high profile failures in environmental performance in the Petroleum industry leading to reduced share prices in the relevant companies compared with their peer group. Kiernan (2001) presents evidence that superior eco-efficiency and 'eco-value' are helping to improve financial performance in a range of sectors. Kiernan (2001:11) suggests that:

> *'perhaps of even greater significance is the confluence of a number of macro-level structural forces that give every indication of creating an even larger eco-value premium tomorrow and in the future'.*

These forces include:

- the tightening of domestic and global legislation;
- the globalisation and intensification of industrial competition;
- changing consumer/investor demographics with younger 'greener' consumers and investors;
- growing institutional shareholder activism;
- growing CEO/CFO awareness of the competitive and financial benefits of superior environmental performance;
- global pollution and resource consumption pressures;
- increased transparency and velocity of information; and
- pressure from NGOs.

Kiernan (2001:11) suggests the above forces are individually each powerful enough to expand the 'eco-value' premium, and that taken together *'they are a virtually irresistible force that seems certain to transform the global competitive landscape for at least the next decade'.*

Anecdotal evidence suggests that sales can be inhibited or increased by public evidence of a company's environmental performance (Elwood and Case 2000). In 1994, a Dutch consumer magazine rated Sony televisions as a *'reasonable buy'* in comparison with two competitors rated as *'best buy'*, with the primary difference between these products identified as their environmental performance. After the publication of these results Sony's market share in the Netherlands fell by 11.5% and the share price for the competitor companies identified as 'best buy' rose by 57.1% and 100%. Sony then introduced the 'Greenplus Project', setting strict environmental criteria that Sony products should meet. In 1998, the same consumer magazine rated Sony above its competitors and its market share subsequently increased steadily in the Netherlands (Elwood and Case 2000: 73). No empirical evidence is available of improved sales related *directly* to improved environmental performance in the cases of Ben & Jerry's, Patagonia, Canon, Collins, Volvo and Aikman Floorcoverings Inc., also detailed in Elwood and Case (2000). However, all these companies report anecdotally that improving environmental performance is a significant contributing factor to their improved sales performance.

The participants in the BSREF study report that their supply chain environmental initiatives are yielding substantial benefits and they are a potential source of competitive advantage (Gavaghan *et al.* 1998). Specific cases are identified where working with suppliers improved product quality, reduced production times, heightened productivity, contributed to product innovation, reduced R&D costs and increased market share.

Green *et al.* (1996) discusses the importance of investor pressure on improvements in environmental performance, with eight out of fifteen companies they studied citing investor pressure as a factor in the development of an environmental policy. The willingness of investors to invest in a company is a competitive factor as it leads to a more robust share price. Investor pressure is also a factor noted by Klassen and McLaughlin (1996) who state that when environmental performance is made public it alters an investor's valuation of a firm's perceived future financial performance.

Clayton and Rotheroe (1997) found that 26% of a sample of companies that were assessing the environmental performance of suppliers had ceased to use suppliers on environmental grounds. However, as Baylis *et al.* (1998b) notes the environmental performance of a supplier tends to be only one of a number of reasons why they are no longer used by an organisation.

Interest in environmental issues by the logistics industry has been most clearly manifested in the area of 'reverse' logistics in terms of exploiting new market opportunities, opening up the markets for recycling and disposal (Rodrigue *et al.* 2001), and . Re-manufacturing is a lucrative new revenue source, allowing firms to replace a few parts and testing worthiness, and resulting in a product that can be resold (Davis 1996). Specific examples of new 'products' and revenue streams from reverse logistics are identified by Stock (1998).

In summary, the competitive/ financial factors are classified in this research as external factors as they affect the external perception of the profitability of an organisation. The discussion presented in this section suggests that improving environmental performance may lead to competitive and financial benefits, which include:

- Operational cost savings (Baylis *et al.* 1998b; Elwood and Case 2000; Krikke *et al.* 1999);
- New markets for products and services (Davis 1996; Elwood and Case 2000; Rodrigue *et al.* 2001; Stock 1998);
- Security of future sales (Elwood and Case 2000);
- Improved share performance (Feldman *et al.* 1997; Plesse 1992);
- Improved investment profile (Green *et al.* 1996, Kiernan 2001; Klassan and McLaughlin 1996); and
- Better positioning in the market place in comparison with competitors (Elwood and Case 2000; Gavaghan *et al.* 1998).

3.3.1.3 Supply chain pressure

Hill (1997), with specific reference to manufacturing firms, argues that environmental pressure can be conceptualised as moving *along* the supply chain from the customer end of the supply chain (both individual consumers and industrial customers), to the organisation in question and from them to their suppliers.

Elwood and Case (2000) present a range of anecdotal company examples where their customers (both industrial and individual) have expressed an interest in the environmental performance of that company. Yet Daimler Chrysler are concerned that there is little indication of a strong correlation between individual consumers' words and their actions (Elwood and Case 2000). This 'green purchase gap' (after Peattie 1995) is discussed in more detail in chapter two. Yet, the BSREF study of 'leading edge' organisations and their green supply chain management practises (Gavaghan *et al.* 1998), all identify customer interest in environmental issues as a factor in the implementation of their programmes.

However, Hill (1997:1259) argues that more environmental pressure is exerted by customers on suppliers than by suppliers on their customers. Apart from a rare monopolistic situation, customers almost always hold the balance of power. Although suppliers can actively market green goods and encourage their adoption by customers. Retailers effectively act as the agent between green consumers and manufacturing firms. Due to their bulk buying capabilities these retailers may be in a position to 'force' manufacturers to incur the costs of developing new 'greener' products (Hill 1997: 1260). Whilst the 'customer' normally holds the balance of power, the issue of channel power as discussed in section 2.2.1, suggests that when the customer is 'smaller' and less influential than it's supplier, requests to change practices may not be listened to. Thus, the issue of critical dependency is also important in this context. A customer who is reliant upon a single or limited source of materials cannot 'afford' to lose a particular supplier.

Baylis *et al.* (1998b) argues that pressure from organisational/ industrial customers to improve environmental performance, when expressed through green purchasing, should be tailored to SMEs rather than using generic 'one size fits all' requirements. Only 26% of SMEs identify customer pressure through the supply chain as influential, as opposed to 43% of larger company respondents, yet 56% of these SMEs have received customer enquiries about their environmental performance (Baylis *et al.* 1998b). However, none of the SMEs reported losing custom when they reported to a customer that they did not have an environmental policy. In the Rao (2002) study the close link between Taiwanese firms and their SMEs suppliers is overcoming the inertia traditionally experienced by SMEs who fail to improve their environmental performance.

> *'Treating suppliers as part of the extended family, Taiwanese firms have succeeded in the implementation of waste minimisation amongst SMEs'*

(Antonio 2000 cited in Rao 2002: 634).

Rao (2002) also describes the case of the Ford Motor company that demanded that all of their manufacturing suppliers (about 5000 companies world-wide) must gain accreditation to an environmental management standard for at least one plant by end of 2001 and all plants by 2003. This process is being facilitated by seminars run by Ford. A similar process was initiated at B&Q (Knight 1995), and many large companies are beginning to develop supplier auditing systems.

In summary, pressure can be exerted on organisations through the supply chain and examples include:

- Environmental requirements set by an organisation on it's suppliers (Knight 1995; Rao 2002);
- Encouragement from organisations a company supplies to, but without deselection should environmental management initiatives not be adopted (Baylis *et al.* 1998b);
- Pressure from individual customers (Elwood and Case 2000; Gavaghan *et al.* 1998); and
- Influence on a company from it's own suppliers, who have perhaps adopted environmental initiative of their own (Hill 1997; Knight 1995).

3.3.1.4 Societal pressure

Societal pressure is a term used to describe the intangible pressure from society's expectation of 'how' an organisation should behave. These 'societal norms' are a reflection of a collective set of minimum behavioural standards[4].

[4] At an individual level a person's beliefs and values might be shaped by their exposure to formal environmental education, and informally through the media and society (explored in more detail by Holt and Anthony 2000).

A growing number of '*eco-savvy*' corporations are focussing on marketing their environmental performance as part of their business strategy, yet surprisingly few companies take full advantage of promoting their environmental performance in marketing and communications initiatives (Axelrod 2000:7). Such marketing efforts can shape the image of an organisation and reassure the general public and organisations linked to them through a supply chain that they are not an environmental liability/risk. Evidence that a company complies with all environmental, health and safety regulations is a minimum price of entry for doing business, especially in the EU, suggests Axelrod (2000) and organisations can use marketing and communication efforts to diffuse this information about themselves to the wider business community. Protection or enhancement of the image of a company is an important driver of environmental management initiatives (Holt 1998; IM 1998; Rao 2002). In the Rao (2002) study 97% of the respondents' state that accrediting to an EMS improved their corporate image.

The image of an organisation is shaped by the opinions of individual customers and its perception by 'society' generally. Consumer opinion and responding to environmental pressure groups, such as Greenpeace, are key drivers identified by the Institute of Managers study (IM 1998). Being a good neighbour and public concern is identified as a motivation for improving environmental performance by 48% of SMEs and 63% of larger companies in the study by Baylis *et al.* (1998b). Pressure to be a 'good neighbour' is also cited by five of the fifteen firms examined by Green *et al.* (1996).

The image of a company can also be affected by wider CSR issues, with organisations such as Nike criticised for the use of child labour in their suppliers' workshops (Young and Kielkiewicz-Young 2001). Bremer and Udonvich (2001) also note the pressure multinationals face to monitor compliance with workplace labour standards in their facilities or subsidiaries in developing countries.

Societal pressure is a relatively intangible driver but such societal pressure might be associated with:

- Responding to public opinion (Baylis *et al.* 1998b; Bremer and Udonovich 2001; Young and Kielkiewicz-Young 2002);
- Maintaining the image and reputation of a company as 'environmentally' or 'socially' responsible (Axelrod 2000; IM 1998; Rao 2002);
- The role of environmental pressure groups (IM 1998; Young and Kielkiewicz-Young 2002); and
- The general expectation of society (Green *et al.* 1996; IM 1998).

3.3.2 Internal Drivers and Environmental Attitude

Carter and Ellram (1998) stress the need to examine internal factors as well as external environmental factors driving green logistics. Section 3.2 suggests five groups of drivers that might be influential in any green supply chain model. Four of these are defined as external drivers and discussed in section 3.3.1. The final group is that of 'internal' drivers and is discussed in this section, along with the concept of 'environmental attitude' as a surrogate measure of internal drivers.

3.3.2.1 Internal Drivers

Inside an organisation, pressure from employees, leadership from environmentally committed management and perception of possible environmental risk might all contribute to changes in environmental practices in organisations. Employee concerns are identified by Baylis *et al.* (1998b) as a driver of environmental improvement in 38% of SMEs and 48% of larger companies. Whilst, 51% of SMEs and 56% of larger company respondents suggest that concern for environmental issues is influential at the individual level, suggesting the key role individual values might play in an organisation.

Specific employees can be very influential. These are the so-called '*green champions*' that are responsible for, and drive, environmental initiatives. Preston (2001) explores the influential role of green champions in sustainability initiatives at Hewlett Packard. Drumwright (1994) identifies three different types of individuals in organisations. The *policy entrepreneurs* are individuals who are prepared to go to personal expense to put forward important environmental issues in a company and who use their knowledge as a power base to prick the organisational conscience. Secondly the *converts* are those who eventually embrace green policies, often after initial resistance, and perhaps with great fervency and, thirdly the *resisters* who do not see the need to modify the environmental behaviour of their organisation. Arguably, the 'penetration' of a green ethos into an organisation might be dependent on which of these three types of individuals are in the highest position of responsibility and how much decision making power they have.

If a '*policy entrepreneur*' is a member of upper management there may be a greater organisational commitment to environmental performance improvement. Mintzberg (1973) identifies top management support as fundamental to the successful adoption and implementation of new programmes and activities. The management function acts as a leader, liaison, disseminator of information, allocator of resources and negotiator (Carter *et al.* 1998; Mintzberg 1973). Ghobadian *et al.* (2001) identifies the internal drivers of senior management leadership (average score of 4.02)[5], corporate image (3.67) and corporate tradition (3.12) as the highest ranking moderating factors affecting the development of a corporate environmental strategy. Yet, some argue that the most influential employee group to instigate environmentally responsible buying programmes is not the CEO and upper management but the middle managers. These 'policy entrepreneurs' in middle management positions tend to have power and influence and are personally committed to environmentalism (Drumwright 1994). In multiple regression models of drivers of green purchasing, Carter *et al.* (1998) found that top management support is a not significant driver, whilst the support of middle management is.

A number of organisations publicly state an organisational level commitment

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5 Likert scale ranked 1 (very low importance) to 5 (very high importance)

to developing 'environmentally responsible' or 'green' operational practices. In the BSREF studies (Gavaghan *et al.* 1998; Lippmann 1999) *'leading edge'* firms are examined. These organisations espouse strong environmental values, and managing the supply chain for environmental responsibility is part of this ethos. Some organisations such as Body Shop have built their entire business profile on socially and environmentally responsible behaviour. Others such as the UK DIY firm B&Q, have transformed some of their product ranges to incorporate an environmental dimension and are very open about their 'environmental-correctness' stance (in Green *et al.* 1998).

Therefore internal drivers may be influenced by:

- Top/middle management support (Carter *et al.* 1998; Ghobadian *et al.* 2001; Mintzberg 1973);
- General employee concern (Baylis *et al.* 1998b);
- Influential individuals such as the CEO or 'green champions' (Drumwright 1994; Ogbonna and Harris 2001; Preston 2001); and
- An environmentally committed organisational culture (Gavaghan *et al.* 1998; Green *et al.* 1998; Lippmann 1999)

3.3.2.2 Environmental Attitude

Makower (1994) suggests that environmentally proactive companies will only thrive if they extend their environmental initiatives into the whole of the supply chain. Walton *et al.* (1998) identifies six strategic approaches to environmental management and suggests that the most advanced companies have the most 'proactive' approach to leveraging environmental management for competitive advantage. The discussion of organisational commitment in the preceding section highlights that the overall environmental culture of the organisation might be very important as a driver. However, as section 3.2.3.1 suggests it is sometimes difficult to establish whether it is employees, upper management, founder ideals, middle management or 'green champions' who drive environmental programmes (Baylis *et al.* 1998b; Carter *et al.* 1998; Drumwright 1994; Ghobadian *et al.* 2001; Ogbonna and Harris 2001).

Therefore, a range of 'actors' within an organisation may influence green supply chain management initiatives and their relative success. Perhaps trying to identify which specific group is the most influential is **less important** than assessing the influence of the overall **organisational** environmental attitude or commitment to improving environmental performance.

It might be argued that company mission statements represent the cultural mindset of an organisation and are a visual 'artefact of culture' (after Brown 1998)[6]. Thus, an environmental policy, or at least an environmental element in the broader corporate mission statements, might signal to all levels of an organisation the need to incorporate environmental considerations into their activities. Many larger organisations now have environmental policies (Ghobadian *et al.* 2001). The presence of an environmental policy is identified by Balylis *et al.* (1998a) as a motivator for improvements in environmental performance, by 14% of SMEs and 50% of larger company respondents. The presence of a formalised environmental policy may be used as a surrogate measure of the environmental behaviour of a supplier. However, such policies might be in place only to appease a potential supplier or as a form of 'green washing'.

Therefore, a mechanism to benchmark the environmental culture of an organisation might be a more suitable substitute for the measure of 'internal drivers'. Murphy *et al.* (1996) suggests a measure of overall '*environmental attitude*' might be suitable and classifies organisations into attitudinal clusters described as 'conservative', 'moderate' or 'progressive', using a series of constructs to develop an environmental attitudinal score but this study focused only on the logistics end of the supply chain. In Bowen *et al.* (2001a), a similar 'clustering approach' to that of the Murphy *et al.* (1996) study is used to identify four archetypal groups of green supply chain management practices. However, this study clustered groups using 'action' based measures around the themes of '*product based green supply*', '*greening the*

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6 See Holt and Anthony (2000) for a detailed exploration of this concept and the positive relationship between individual environmental values and corporate values.

supply process' and *'advanced green supply'*. Only the first of these, 'product based green supply' included three constructs that could be associated with the logistics function (associated with reducing waste and recycling) and the majority of the constructs in this study focused on the purchasing function.

Clustering respondents into archetypal groups, or a taxonomy, as a method of identifying strategic configurations and representing the diversity and complexity of 'organizational reality' is examined by Tsikriktsis (2004) and Ketchen and Shook (1996), and can be a critical element within theory development (Bacharach 1989). The use of descriptive taxonomies to identify environmental strategies in organisations is well established, examples include Roome (1992), Ghobadian *et al.* (1995b) and Azzone *et al.* (1997). More recently, empirical taxonomies of strategic environmental management have been developed using cluster analysis and principal components analysis (Aragon-Correa 1998; Henriques and Sadorsky 1999).

However, only two previous studies develop empirically based taxonomies of environmental attitude and behaviour related to green supply chain management (Bowen *et al.* 2001a and Murphy *et al.* 1996.). In the work by Bowen *et al.* (2001a) K-means cluster analysis is used to develop the taxonomy, compared with the self selected cut off points used by Murphy *et al.* (1996).

Other studies that develop empirical based strategic environmental taxonomies include the work of Henriques and Sadorsky (1999) and Aragon-Correa (1998), but neither of these two studies specifically focuses on green supply chain management practices. In the Henriques and Sadorsky (1999) study the environmental strategy of a cross sectoral study of Canadian firms used the a single measure developed from constructs on the extent of the environmental plan/policy, as an indicator of the level of environmental commitment (in a similar manner to the measure of environmental attitude discussed by Murphy *et al.* 1996) and compared this with the influence of different stakeholder groups. Whereas, Aragon-Correa (1998) focuses on the relationship between general business strategies and their strategies related to the natural environment, in a cross-sectoral sample of Spanish firms. In this study the 14 environmental management issues were examined where respondents positioned themselves on a scale from not addressing this issue through to their perception as leaders on this issue in their sector.

Thus, the internal 'commitment' of an organisation to improving their environmental performance may be affected by a number of internal 'actors'. Since it is difficult to detangle the relative influence of each group within that organisation it may be more useful to establish it's overall 'environmental attitude'. Rather than using a simplistic measure, such as the presence/absence of an environmental policy, a multi-construct measure of environmental attitude might be developed based on the principles established by Murphy *et al.* (1996). Organisations may also be clustered into taxonomies or organisational clusters to facilitate the identification of the diversity between them, such as the attitudinal clusters used in the Murphy *et al.* (1996) study.

3.3.3 Moderating influence of Barriers/ Obstacles to Green Supply.

A variety of internal obstacles might constrain the adoption of environmental initiatives in organisations. In a survey of NAPM[7] members in industries that produce lots of scrap waste, Min and Galle (1997) investigate nine items associated with obstacles to environmental purchasing. Barriers associated with cost are the most influential in their study, linked to the high cost of environmental programmes and the lack of economic viability for recycling and reuse. The second group of barriers is associated predominately with internal capabilities (lack of management commitment, lack of buyer awareness, lack of supplier awareness and lack of company wide environmental standards or environmental auditing programmes). The least influential obstacles are associated with 'loose' state and federal environmental regulation[8]. Yet, the constantly changing nature of government

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7 National Association of Purchasing Managers, based in the USA

8 The nine items ranked on an adjusted rank scale into three groups in descending order.

regulation is a key obstacle to environmental purchasing identified by Walton *et al.* (1998).

Murphy *et al.* (1995) also investigates obstacles in aspects of green supply chain management. In this case the barriers to green logistics are identified amongst a sample of US manufacture's and merchandisers. In this study five specific items are examined: items associated with high costs, lack of benefit and lack of resources are the most common obstacles in this study (table 3.7).

Table 3.7: Obstacles to green logistics (from Murphy *et al.* 1995)

Obstacles	% Respondents
Lack of Resources	42.4
High cost of environmental compliance	42.4
Lack of perceived benefit	32.3
Company wide indifference	12
Lack of top management support	8.3
Other (open responses)	12.8

In addition to the items used in the Murphy *et al.* (1995) survey, respondents also identified in the open section of the questionnaire other possible obstacles. These were:

- Lack of knowledge of all the issues;
- Uncertainly as to the degree and nature of government regulation; and
- Lack of technological solutions.

Table 3.7 supports some of the findings of Min and Galle (1997), with financial aspects (*cost of compliance and lack of perceived benefit*) amongst the most influential barriers but the difference between the different measures used makes direct comparison difficult. In the Min and Galle study lack of supplier awareness is the ranked sixth (in the unadjusted rank scale) from a possible nine items) but this aspect is not examined in the Murphy *et al.* (1995) study. Walton *et al.* (1998) identifies supplier resistance as a key obstacle to the instigation of environmental purchasing schemes. In all three of these previous studies, the results reflect the findings from a US sample, in specific industries (manufacturing and merchandising), rather than a cross-sectoral sample. Min and Galle (1997) also state that one of the main hidden obstacles that emerges from their findings is the lack of systematic method to aid purchasing professionals in accurately measuring the costs and benefits of environmentally preferable purchasing.

The internal factors in an organisation (reflected by environmental attitude and associated internal drivers) which are promoting green supply chain management initiatives may be negatively affected by internal obstacles associated with cost, capability and resource issues, for example the lack of top management support identified by Murphy *et al.* (1995). In addition, the external drivers such as environmental legislation may be affected by a perception of internal obstacles associated with them, for example high costs of environmental compliance (Murphy *et al.* 1995). Thus, any investigation of the relationships between external drivers, internal drivers (including environmental attitude) and green supply chain management activities must incorporate the potential moderating influence of internal barriers/obstacles.

3.3.4 Moderating influence of Organisational contingencies/ Demographic Characteristics

Sections 3.3.1 and 3.3.2 indicate that there are a broad range of possible drivers/motivating factors affecting the environmental behaviour of organisations. However, there are differing levels of importance assigned to these pressures (Hall 2000; 2001), for example the relatively different levels of importance placed on the drivers in tables 3.2 and 3.5 (IM 1998; Rao 2002). Mitchell *et al.* (1997) argues that variances in stakeholder pressures arise from differences in power, urgency and legitimacy and these differ between firms. It could be questioned whether these differences in ability to influence others is an individual firm trait, or whether these differences in pressures might be identified according to specific characteristics of the organisation, such as sector or size. Arguments for adopting a cross-sectoral approach in this study are presented in section 1.3.4. This section further expands upon this argument by examining the differences in different levels of pressure driving environmental behaviour in organisations. Baylis *et al.* (1998b) perhaps best encapsulate the importance of understanding how different organisational contingencies (i.e. the individual characteristics of organisations) affect their environmental behaviour and the relationships between drivers and operational response. They state that:

> *'If industry is to be encouraged to improve environmental performance, the information it is given must be sensitive to individual circumstances of firms, and should therefore recognise that they are subject to different levels and types of internal and external pressures and may not necessarily gain the same benefits'* (p. 294)

The respondents in this study are classified using a variety of organisational contingencies as discussed in the next section and include:

- Size ;
- Sector ;
- levels of environmental risk and impact;
- dependency on suppliers and customers; and
- nationality

3.3.4.1 Size

Hall (2000) identifies variances in pressures associated with organisational size, with smaller firms' lack of knowledge, or lack of overt pressure through accountability issues, leaving them relatively unaffected by environmental issues. Yet, Murphy *et al.* (1995) describe how smaller firms experience more obstacles to green logistics activity than larger firms, associated with lack of benefits and high costs. However, it should be noted that Murphy's 'smaller' firms are not SMEs, but larger firms with less than $1billion revenue. Whereas the organisations in Hall's study are all significantly smaller in size and revenue. Hill (1997) found that firms most likely to make changes in response to green supply chain pressures are larger, corporately owned, older and involved in the manufacture of finished goods in the higher risk industries (in this case chemicals and the printing sector). Baylis *et al.* (1998b) also found that size is an important factor with large companies identifying 48% more pressure to make environmental improvements than SMEs. Preuss (2001) found mixed evidence on the influence of size, suggesting that sector was an important distinction.

3.3.4.2 Sector

Murphy *et al.* (1995) identify significant differences in green logistics practices and obstacles affecting organisations, related to both size (based on those with more or less than $1 billion dollars in revenue) and sector (manufacturers or merchandisers). However, this study only applies to large companies in two sectoral groups in the USA. In the case of perceived environmental uncertainty Lewis and Harvey (2001) also identify different levels of pressure in different sub-sectors of the textile industry

Another factor that appears to be influential is the distance from the end consumer, with Green *et al.* (1996) and Hall (2000) suggesting that there are sectoral differences in terms of pressure to change environmental behaviour that are related to this distance from the end consumer. Recognisable consumer goods often associated with large multinationals gain a great deal of consumer attention. The Chartered Institute of Purchasing and Supply estimated in 1993 that consumer spending in the UK was £400 billion, yet inter-corporate trade was over £750 billion (Green *et al.* 1996). This means that individual consumer pressure might be less likely to impact the inter-corporate environment. The impact of environmental pressures upon different sub-sectoral groups of manufacturing firms and how this affects their operational response is suggested as an important area for future investigation by Hill (1997) and this study suggests that this is an area subject to little systematic investigation to date. Supply chain environmental pressures particularly in the business to business context, compared to business to consumer, is the subject of limited discussion, according to Hill (1997).

Baylis *et al.* (1998c) found marked sectoral differences in large organisations receiving enquiries on their environmental performance, but no significant differences in their SME group. This suggests interplay between industry contingencies such as size and sector. Baylis *et al.* (1998c:285) examine this interplay stating that:

> *'not simply that firms respond to, or their behaviour can be explained by,*

a single factor. Rather business perceptions and motivations are built upon a combination of factors of which sector is one'

3.3.4.3 Environmental Risk/ Impact

Rather than use 'sector' as a defining characteristic of an organisation it may be more pertinent to use an assessment of their level of environmental risk or environmental impact. Baylis *et al.* (1998b) notes that green purchasing is more likely to affect industrial sectors that are perceived to have a poor environmental image, high environmental risk, or greater variability due to their closeness to the end consumer. As discussed in section 1.3.4 some of the previous research studies on aspects of green supply chain management deliberately target respondents in 'dirty' or higher risk industries arguing that they are more likely to be engaged in environmental initiatives.

3.3.4.4 Power of the Organisation in the Supply Chain- Dependency on customers and suppliers

Channel power, the influence of one organisation within a supply chain to influence another, is also important (El-Ansary and Stern 1972). As discussed by Hall (2000) not all firms experience the same level of pressure. New *et al.* (2002) notes that the leverage of the public sector could be important where this sector may be the most important, or only, customer. Interestingly one of the cases that Walton *et al.* (1998) describes, details how a 'make-to-order' furniture manufacturer approached their supplier of foam packaging to request that this was changed to a recyclable material, the supplier refused and the customer ceased to purchase from them. Yet 80% of this supplier's business was supplying this particular customer.

Baylis *et al.* (1998b) also discuss the fact that an SME is not always the supplier to a larger firm in a supply chain (also discussed by Holland and Gibbon 1996), and thus 'upstream' of the larger firm. The implication of this is that a smaller firm cannot necessarily leverage influence against a larger company through the SME's 'power' as an industrial customer. Green *et al.*

(2000) suggest that industrial customers can intervene in greening supply chains but this is limited by the power the individual organisation may have, as it is embedded in various chains and networks. In the paper by Hall (2000) the Japanese supermarket chain examined seemed unaffected by pressure from consumers, pressure groups or the media, and the limited channel power the supermarket had over the majority of it's suppliers resulted in an inability to effect change. However, in the same paper a Japanese convenience store industry did have a strong influence with a specific group of suppliers (Bento), and there was evidence of environmental supply chain dynamics (diffusion of environmental innovations from customer to suppliers) emerging. Hall (2001) describes the concept of a sphere of influence over suppliers and a sphere of concern over the actions of others.

Green *et al.* (1996) believe that understanding green supply chain management practices and the role of industry structures allows environmental legislation and pressure group activity to be more precisely targeted. Their study suggests future work should examine how differences in supply chain structure and inter-corporate power affect diffusion of green supply. The influence of inter-corporate power and organisational characteristics may result in considerable differences in the process and effectiveness of green supply chain management when the main influencing company differs in commitment, sector and power (Green *et al.* 1996, 1998).

Channel power may be a key influence upon the 'green multiplier effect', which is the process by which environmental values, beliefs and standards 'should' theoretically cascade through the supply chain as a result of a green supply chain management. The green multiplier effect has received little attention in prior research with the exception of work by Ytterhus *et al. (*1999) and Preuss (2001). This 'green multiplier' effect might be enhanced, reduced or fail to materialise due to a range of factors, one of the most critical of these factors might be the 'channel power' that an individual organisation has within the supply chain (after Hall 2000). The concept of the green multiplier effect arguably pre-supposes that the instigator of a green supply chain programme is more powerful than it's suppliers. None of the studies examined in table 1.1

examine in detail green multiplier effect and the specific influence of channel power on this, suggesting a rich avenue for future research.

In addition to channel power the specific issue of what could be called 'critical dependency' is important. This is the concept of how dependent a customer is on a particular supplier, or dependency of a particular supplier on business from a specific customer. This would apply when a customer is solely dependent on a small group of suppliers for critical components where there is no alternative substitute, or whether geographical or logistical restrictions make alternative sources of supply an unlikely alternative. This idea of critical dependency appears not to have been specifically examined in previous research in green supply chain management literature. However, Pesonen (2001) discusses the position of partners in industrial networks from the perspective of changing processes and products to satisfy one customer and then becoming more dependent and vulnerable to that one customer.

3.3.4.5 Nationality

The nationality of an organisation may affect it's environmental performance. For instance Carter *et al.* (1998) identify that German firms have significantly more green purchasing operational activity than US and other EU counterparts. Yet, Murphy and Poist (2003) identify no significant differences in the majority of green logistics strategies between US and non-US firms.

The studies identified above all examine firms in 'developed' countries who have arguably higher levels of environmental legislation that 'developing' nations. Zhu and Geng (2001) note that many Chinese enterprises feel that environmental initiatives are important to address real or anticipated international requirements of foreign enterprises such as IBM or Xerox. The role of international expectations of environmental performance by firms in developing countries is also noted by Rao (2002) in a study of environmental 'leading edge' firms in S.E Asia. Thus, whilst the business culture at a national level may not consider environmental issues of importance, the threat of losing international customers may lead to the adoption of green initiatives, but only arguably amongst those firms that export, leaving the domestic organisations relatively unaffected.

3.3.5 Summary

Section 3.3 identifies that there are a range of external drivers and internal factors that might be affecting green supply chain management practices. The key findings from this section suggest the following:

- The drivers of environmental initiatives in organisations can be grouped into five categories, external drivers associated with legislation, competitive/financial factors, the supply chain and societal factors (section 3.3.1) and internal drivers (section 3.3.2);
- Internal factors may include internal drivers (section 3.3.2.1), environmental attitude reflecting organisational environmental culture (section 3.3.2.2), and internal obstacles to green supply associated with cost, capability and resource issues (section 3.3.3)
- There may be variability in external and internal pressure associated with demographic characteristics of the respondents (section 3.3.4).

3.4 Possible relationships between drivers and operational activity

So far, this chapter establishes that there are a range of external drivers and internal factors that may exert pressure on organisations to change their environmental behaviour. The presumption within all the previous studies on aspects of green supply and environmental management generally is that such pressure leads to *actual* changes in management practices. This presumption suggests that there are *specific relationships* between the 'pressures' driving green supply chain management and operational response and as such these relationships might be statistically tested. Only a few of the studies identified in table 1.1 and appendix 1.1 statistically tests influences on environmental behaviour and these are detailed in table 3.8.

Table 3.8: Previous statistically tested models on environmental behaviour.

Reference	General Description
Banerjee *et al* 2003	Influence of antecedent and industry type on corporate environmentalism in areas of Environmental Strategies and Marketing Examination of influence of industry type. Examines external and internal drivers and operational activity
Bowen *et al.* (2001b)	Tests model of green supply chain management capabilities and green supply chain operational activity (single composite measure), amongst cross-sectoral sample. Influence of demographic characteristics not tested in model
Carter and Carter 1998	Models and tests interorganisational factors and how they affect environmental purchasing Did not examine internal organisational factors. Limited sectoral focus. No examination of demographic characteristics
Carter and Jennings 2002	Models and tests relationship between purchasing for social responsibility and relationship with suppliers. Specific focus on purchasing and suppliers rather than wider green supply. Limited sectoral focus No examination of demographic characteristics
Carter *et al.* 1998	Test difference between levels of environmental purchasing in US and Germany. Limited sector focus. No examination of demographic characteristics except nationality
Henriques and Sadorsky 1996	Empirically tests the determinants of an environmentally responsible firm. Looks at external and internal drivers Only uses sector in statistical model not size. Uses extent of environmental plan as only operational measure
Langerak *et al.* 1998	Models antecedent of green marketing amongst sample of firms in Netherlands. Model does not test influence of demographic characteristics.
Rao 2002	Models and tests green supply chain management practices and drivers in leading edge firms in SE Asia, using structural equation models. No examination of demographic characteristics/ industry contingencies in model
Schaper 2002	Green behaviour amongst retail pharmacies in Western Australia, and relationship of the owner/manager in these SMEs

Table 3.8 identifies that only two of the statistical models examine relationships in green supply chain management specifically (Bowen *et al.* 2001b; Rao 2002), two examine aspects of green purchasing (Carter and Carter 1998; Carter *et al.* 1998), one examines wider aspects of socially and environmentally responsibly purchasing (Carter and Jennings 2002) and the remainder examine general aspects of environmental management and marketing. Since there is such a paucity of research on *empirically* testing specific relationships between the drivers of green supply chain management, a number of theoretical relationships can be postulated based on all the descriptive, theory building and empirical studies identified in appendix 1.1 (and summarised in table 1.1), as detailed in table 3.9.

Table 3.9: Possible relationships between external drivers, internal factors and green supply chain management operational response[9]

	Green Supply Chain Operational Activity
External Drivers	Banerjee *et al.* 2002; Canning and Hanmer Lloyd 1998; Carter and Carter 1998; Carter and Dresner 2001; Carter and Jennings 2002, 2004; Elliot *et al.* 1996; Florida 1996; Gavaghan *et al.* 1998; Hall 2000; Hill 1997; Holland and Gibbon 1997; Holt 1998; Langerak *et al.* 1998; Murphy *et al.* 1995, 1996; New *et al.* 2002; Polgreen 2002; Preuss 2001; Rao 2002; Strong 1995
Internal Drivers	Banerjee *et al.* 2002; Bowen *et al.* 2001a, 2001b; Carter and Jennings 2002, 2004; Carter *et al.* 1998, de Bakker *et al.* 2002; Drumwright 1994; Elliot *et al.* 1996; Florida 1996; Geffen and Rothenberg 2000; Halme 2002; Hill 1997; Holt 1998; Langerak *et al.* 1998; Murphy and Poist 2000, 2003; Murphy *et al.* 1996
Environmental Attitude	Bowen *et al.* 2001b; Henriques and Sadorsky 1999; Murphy *et al.* 1996
Obstacles	Carter and Dresner 2001, Carter *et al.* 1998; Min and Galle 1997; Murphy *et al.* 1995, 1996; Preuss 2001

If such relationships exist, section 3.3.4 also suggests that they may be moderated by the demographic characteristics of the respondents. Yet, few of the previous studies identified in table 3.8 statistically test the moderating influence of these, with only Carter *et al.* (1998) examining the moderating influence of nationality, and Banerjee *et al.* (2003) and Henriques and Sadorsky (1996) examining industry type/sector.

Since there are so few antecedent protocols on what relationships should be statistically tested in this model, all of the possible relationships are initially examined in this study (chapter 10). The final version of the green supply chain management pressure/ response model presented in the concluding chapter (chapter 11) identifies which of these relationships are statistically significant.

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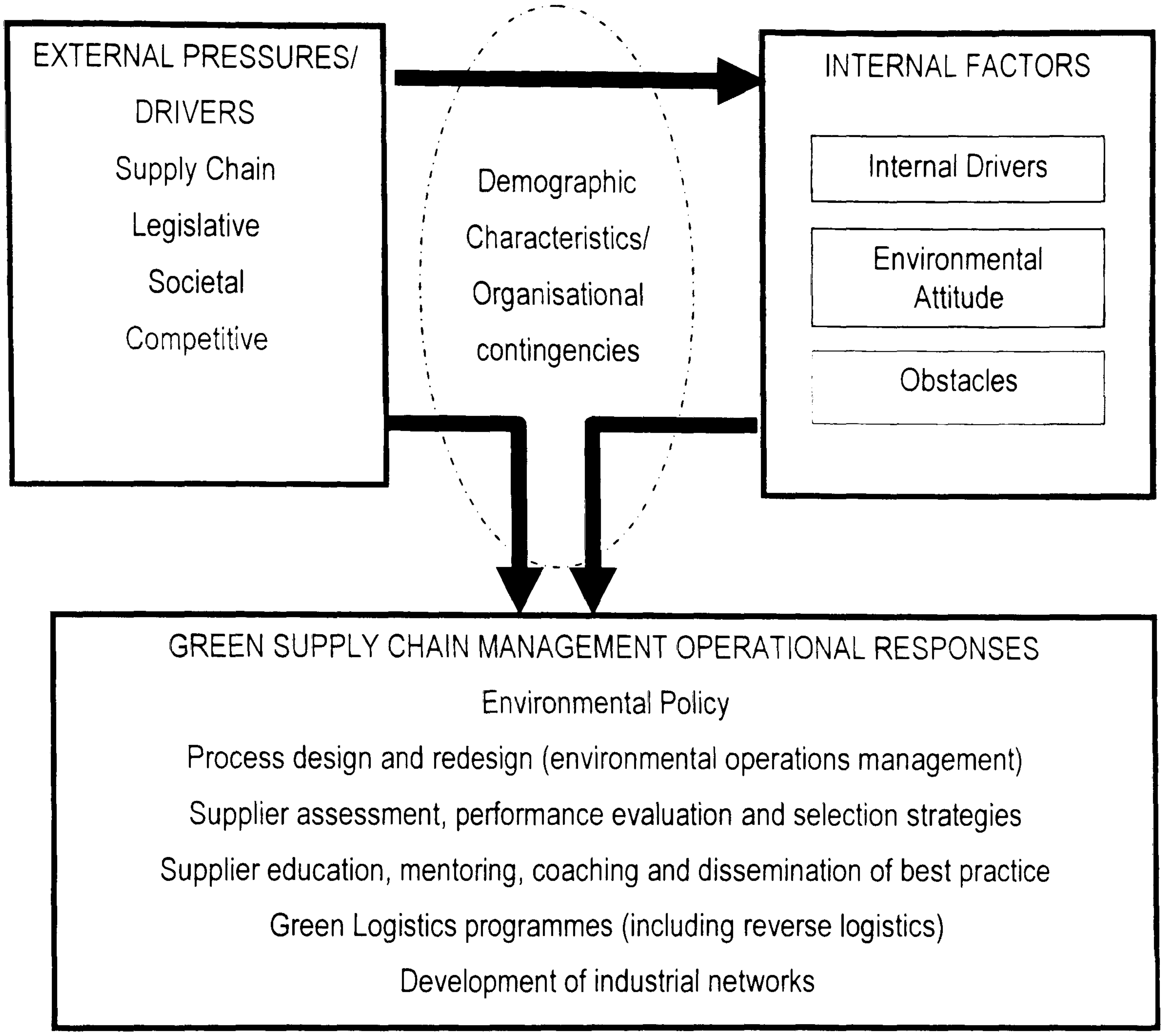
9 Table 3.9 is derived from table 1.1 and incorporates only those studies designated as 'Purchasing', 'Logistics', or 'Supplier-Buyer', or studies designated as 'other' that include aspects associated with greening the supply chain and their relationship with external drivers or internal factors.

3.5 Green Supply Chain Management Pressure/Response Model

Figure 3.2 summarises the discussion presented in this chapter in the form of a pressure/ response model of green supply chain management, which forms the theoretical basis of this study and subsequent statistical analysis. Section 3.3.4 suggests that different types of organisations may receive and 'translate' environmental pressures in a variable manner and that specific green supply chain management practices may occur at different levels of intensity in different 'types' of organisations.

Therefore the model in figure 3.2 includes a reference to the moderating effect of demographic characteristics. In the analysis of the primary data the influence of a range of organisational and demographic characteristics (such as firm size, sector, dependency and structure) are all examined to see if there are significant differences between organisational groups, in chapters 7 (external drivers), chapter 8 (internal factors), chapter 9 (operational practices) and moderate specific relationships in the pressure/ response model (chapter 10).

Figure 3.2: Model of the drivers of green supply chain management and operational responses



From the literature review and secondary case examples a range of theoretical and actual green supply chain responses are identified. Utilising the literature reviewed in chapter 2, here in chapter 3 and the analysis of the case examples in appendix 3 a series of questions have been identified that allow the researcher to examine green supply management in more detail through a research instrument. The exploration and testing of the model presented in figure 3.2 is presented in chapters 6-10.

CHAPTER 4: THEORETICAL OVERVIEW OF RESEARCH DESIGN AND PROCESS

4.1 Introduction

This chapter examines the theoretical underpinning of the design of the research study. Specifically the following are discussed:

- The nature of management research (section 4.2);
- Philosophical positions underlying the research process (section 4.3);
- Choice of research mode (section 4.4);
- Process of intelligence gathering and literature review (section 4.5); and
- The research techniques adopted (section 4.6).

4.2 Management Research

Management research deals fundamentally with producing and legitimising various forms of knowledge associated with the practise of management, with traditional approaches involving a combination of the key processes of observation, reflection, theoretical conjuring and testing of models and theories (Chia 2003). Tranfield and Starkey (1998) discuss the nature of management research stating that there is a consensus within the discipline, that management research operates within no single agreed ontological or epistemological paradigm and utilises knowledge and research methods often drawn from associated disciplines in the social sciences. The majority of books on research methodology still derive from cognitive disciplines such as sociology, education and psychology (Easterby-Smith *et al.* 2002). Whitely (1984) in an historical review of management research discusses the fragmented nature of management research, stating that it is characterised by a low degree of co-ordination of research procedures and strategies, with researchers undertaking studies in an opportunistic and ad hoc manner. Gill and Johnson (2002) also discuss the 'controversy' that surrounds management research due to the emergence of different schools of management thought and the development of different approaches to research methodology.

Easterby-Smith *et al.* (2002) notes that there are three main factors that make management research distinctive. Firstly that *the practice of management is largely eclectic* with managers needing to be able to work across technical, cultural and functional boundaries and draw on knowledge developed in other disciplines. This exposes the dilemma of whether to examine management from a single discipline perspective, which tends to gain respectability from academic peers (Easterby- Smith *et al.* 2002:8; Gill and Johnson 2002:2), or to examine management from a transdisciplinary approach, which tends to produce results that are of more value to practising managers (Tranfield and Starkey 1998). In this thesis material is drawn from two areas to examine the concept of green supply chain management: management and environmentalism/ environmental studies.

According to Easterby-Smith *et al.* (2002) the second factor that makes management research distinctive is that *managers tend to be powerful and busy people* who expect to see tangible returns on their investment from participation in a research study. Confidentiality issues and a research process that involves significant amounts of time or inconvenience may be impractical and affect the data collected. The primary data collected in this thesis was gathered in conjunction with The Chartered Institute of Purchasing and Supply (CIPS), with the expert consultation and pilot stages taking advantage of access to named individuals, identified and contacted personally by the CIPS. The final survey was sent to selected members of the CIPS, with the expectation that loyalty to their 'own' professional body might compensate for some of the impediment caused by the busy nature of managers in the work place, leading to a possibly improved response rate and quality of data.

The third constraint in management research discussed by Easterby-Smith *et al.* (2002) is that *management comprises of both thought and action,* with managers expecting an emphasis on the practical application of management research. This leads to two distinct forms of research – mode 1, which concentrates on the production of knowledge and theory, or mode 2, which concentrates, on the production of knowledge from application.

Tranfield and Starkey (1998) discuss knowledge-production systems drawing on the work of Gibbons *et al.* (1994) in the debates surrounding mode 1 or 2 research. Mode 1 research follows a more traditional approach whereby knowledge production occurs primarily through academic enquiry, where a distinction occurs between:

> *'what is fundamental and what is applied: this implies operational distinction between a theoretical core and other areas of knowledge such as the engineering sciences where theoretical insights are translated into applications'* (Gibbons *et al.* 1994:19).

As Tranfield and Starkey (1998) note, dissemination occurs downstream of knowledge production with little attention paid to the application of this knowledge by practitioners.

Whereas, mode 2 knowledge-production adopts a transdisciplinary approach characterised by:

> *'research problems framed in the context of application, diffusion of knowledge occurring in the process of production, heterogeneous teams of researchers with mixed skills and experience and a more socially and politically accountable knowledge production process and output'* (Pettigrew, 1995:3).

Recently, Huff (2000) argued for a compromise position between mode 1 and 2 where both theory and practical application is developed.

Whilst this thesis arguably adopts a mode one position, it tends towards the compromise position argued by Huff (2000) in that the study examines, develops and tests theory, but the outcome of the study also leads to a greater understanding of the practical application of the process of green supply chain management. The involvement of managers in the collection of data and subsequent dissemination of results through the CIPS will hopefully educate managers, provide ideas, allow organisations to benchmark themselves and facilitate the development of further green supply research and understanding of the process governing such initiatives.

The process of management research is examined in depth by a number of authors (Buckley *et al.* 1976; Easterby-Smith *et al.* 2002; Gill and Johnson 2002; Jankowicz 1995; Saunders *et al.* 2000) and is detailed in Figure 4.1.

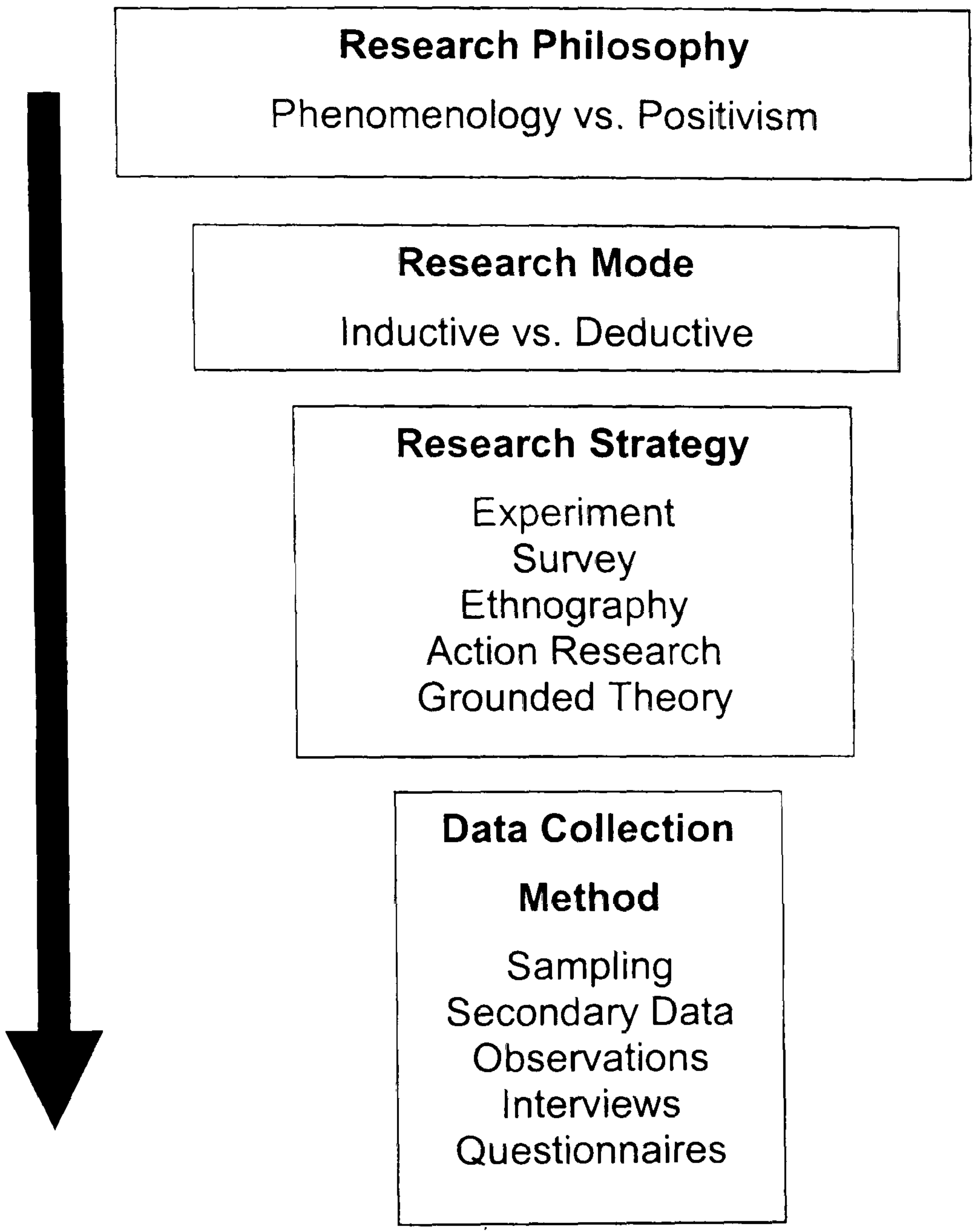


Figure 4.1: The research process (after Saunders *et al.* 2000)

The process that Saunders *et al.* (2000) suggests occurs in layers, or stages (after Buckley *et al.* 1976), involves a series of decisions that ultimately shape the final overall approach to the research design and data collection technique. This chapter examines each of these stages of the management research process.

A number of different forms of research exist related to the proposed purpose of the research undertaken. These forms have been identified as pure research (Easterby-Smith *et al.* 2002; Jankowicz 1995; Cooper and Emory 1995), applied research (Easterby-Smith *et al.* 2002; Cooper and Emory

1995), action research (Easterby-Smith *et al.* 2002), consultancy (Jankowicz 1995) or problem based research (Cooper and Emory 1995).

The key feature of pure research is that it is intended to lead to theoretical development and there may, or may not be, any practical application. It takes the form of discovery, invention or reflection and the results are widely disseminated (Easterby-Smith *et al.* 2002). Cooper and Emory (1995) argue that research is either problem-based research, or pure research. Approaches such as applied research, consultancy and action research are all designed to find solutions to specific problems. Applied research is designed to lead to the solution of a specific problem and involves the application of theory.

However, whilst consultancy and action research are both problem based, and may include application of theory, the key difference lies with the role of the researcher and/or the client. Consultancy involves research to solve a problem set by the client and action research involves a closeness and interaction between observers and the observed, often leading to direct change. This thesis does not involve action research or consultancy.

Whilst the development of the green supply chain pressure/response model in chapter 3 might be considered as pure research, the testing of this model which is the key focus of this thesis, and the findings reported in chapter 7 onwards can be applied to real world situations, and might be classed as applied research.

4.3 Philosophical positions underlying the research process

An understanding of the philosophical schools of thought that underpin management research are important to help clarify research design, to recognise what methods might work in a particular type of study and to offer alternatives that the researcher is not familiar with (Easterby-Smith *et al.* 2002).

4.3.1 Positivism

The philosophical position of the positivist approach is defined by Remenyi *et al.*, (1998:32) as:

> '*working with an observable social reality and that the end product of such research can be law-like generalisations similar to those produced by the physical and natural scientists*'.

The emphasis is on a highly structured methodology to facilitate replication (Gill and Johnson 2002) and where the observer plays an objective analytical role (Easterby-Smith *et al.* 2002) without being affected by, or affecting, the subject of the research (Remenyi *et al.* 1998). Easterby-Smith *et al.* (2002:28) state that:

> *'the key idea of positivism is that the social world exists externally, and that its properties should be measured through objective methods rather than being inferred subjectively through sensation, reflection or intuition'.*

Positivist approaches tend to rely upon quantitative methods of inquiry. Viney (2001:132) details the methods that tend to be associated with the positivist position stating that the extent to which different research methods are associated with the positivist position is determined by (i) the extent to which the approach can be divorced from subjectivity on the part of the respondent/observer and (ii) the extent to which the data collected can be analysed by quantitative methods.

4.3.2 Social Constructionism/Phenomenology

The second philosophical school of thought is that of Phenomenology (Saunders *et al.* 2000) or what Easterby-Smith *et al.* (2002) identify as Social Constructionism. This opposing school of thought to the positivist position argues that the social world of business and management is far too complex to lend itself to theorising by definite 'laws' as in the physical sciences (Saunders *et al.* 2000:86). The key reason for a phenomenologist position is to discover what Remenyi *et al.* (1998:35) identifies as the *'details of the situation to understand the reality or perhaps the reality working behind them.'*

Easterby-Smith *et al.* (2002:29) discuss the concept of social constructionism (as developed by Berger and Luckman 1966; Watzlawick 1984; Shotter 1993) which focuses on the way that people make sense of the world especially through sharing their experiences with others and language. As Easterby-Smith (2002:30) state the essence of social constructionism is that reality is determined by people rather than objective and external factors, suggesting that '*the task of the social scientist should not be to gather facts and measure how often certain patterns occur, but to appreciate the different constructions and meanings that people place upon their experience'.* Qualitative methods of investigation are most closely associated with the phenomenological/ social constructionist position and with more exploratory research (Cooper and Emory 1995).

Figure 4.2 illustrates the different research techniques traditionally associated with these two opposing schools of thought (adapted from Easterby-Smith *et al.* 2002).

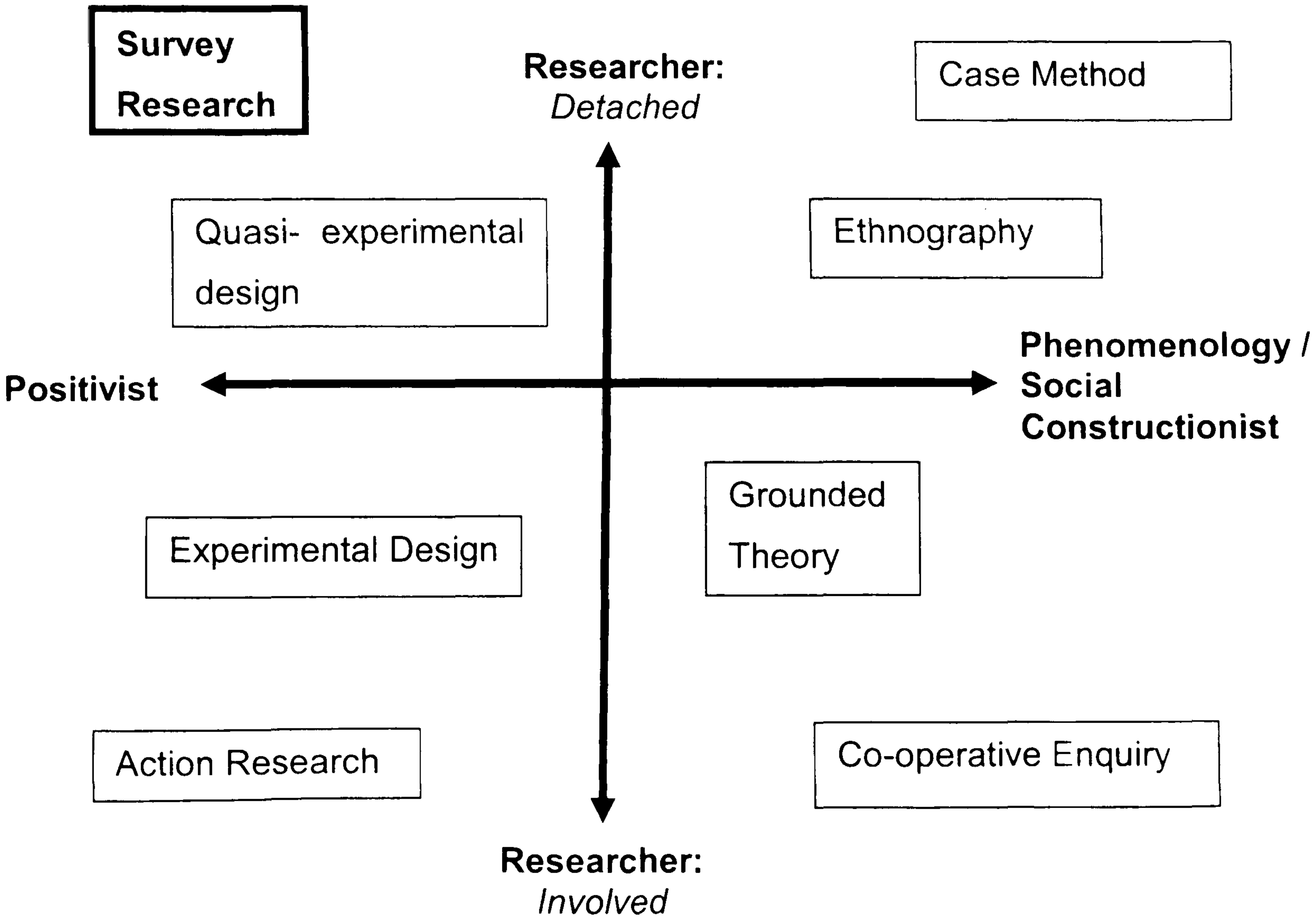


Figure 4.2: Matrix of philosophical approaches and location of research techniques (adapted from Easterby-Smith *et al.* 2002:57)

A third perspective discussed by Easterby Smith (2002) is that of relativism. Collins (1983:88) notes that within the relativist position *'what counts for the truth can vary from place to place and from time to time'*, where the facts depend on the viewpoint of the observer.

Easterby-Smith *et al.* (2002) note a recent variant of the relativist position is the idea of critical realism where a conscious compromise is made, recognizing social conditions as having real consequences but also that concepts are human constructions. The relativist will examine a broad range of viewpoints and tends towards the positivist rather than social constructionist/phenomenology perspective.

4.3.3 Choosing a Research Philosophy

The assumptions and key factors underpinning the philosophical positions discussed above are examined in table 4.1. As Easterby-Smith *et al.* (2002) note, the distinction between these paradigms is clear at the philosophical level but as Burrell and Morgan (1979) stress the difference between these three 'schools' tends to break down when it comes to the choice of specific methods and research design. In practice most researchers do not hold with one single philosophical approach (Easterby-Smith 2002).

The first choice of any research design is the involvement of the researcher. A positivist approach is adopted in this study, where an objective distance from the research subjects is maintained. A cross-sectoral, survey based approach is taken in the primary data collection phase of the study, which belongs to the relativist or positivist position. The debate surrounding whether the data or theory comes first (the concept of grounded theory where theory grows from the data) polarizes the social constructionist versus positivist positions. In the latter, the theory surrounding the topic under study is examined in detail before the data is collected and it is so in this thesis.

Table 4.1: The methodological implications of different philosophical traditions (adapted from Easterby-Smith *et al.* 2002)

	Positivism	Relativism	Social Constructionism
Aims	Discovery	Exposure	Invention
Starting Points	Hypotheses	Suppositions	Meanings
Designs	Experiment	Triangulation	Reflexivity
Techniques	Measurement	Survey	Conversation
Analysis/ Interpretation	Verifications/ falsification	Probability	Sense making
Outcomes	Causality	Correlation	Understanding
Validity	Do the measures correspond closely to reality?	Have a sufficient number of perspectives been included?	Does the study clearly gain access to the experiences of those in the research setting?
Reliability	Will the measures yield the same results on other occasions?	Will similar observations be reached by other observers?	Is there transparency in how sense was made from the raw data?
Generalising	To what extent does the study confirm or contradict existing findings in the same field?	What is the probability that patterns observed in the sample will be repeated in the general population?	Do the concepts and constructs derived from this study have any relevance to other settings?
Main Strengths	Coverage of wide range of situations; Fast and economical; Useful for policy making	Accepts the value of using multiple sources of data Enables generalisations Can be conducted efficiently	Can look at change over time; Can use to understand people's meanings can adjust to new ideas as they emerge; Can contribute to evolution of new theories
Weaknesses	Can be inflexible; Not good for understanding processes; Not useful in generating theory	Large samples needed for credible results; Requirements of standardisation make it difficult to deal with cultural or institutional differences	Data collection can be time consuming; Analysis may be difficult; Lack of recognition for 'subjective' opinions

4.4 Research Mode (Inductive or Deductive)

As Buckley *et al.* (1976) note, prior research is perhaps the most productive source of new research questions and is generated through either an inductive or deductive approach. Gill and Johnson (2002) note that the **inductive** approach is based on the need to base explanations of social phenomena on observation and expertise. It consists of 'fact finding', which leads to the generation of theory. Ghauri and Gronhaug (2002) define induction as the process of observing facts, which lead to propositions and later theories. Cooper and Emory (1995:27) refers to induction as drawing a *'conclusion from one or more particular facts or pieces of evidence'*, describing induction as occurring where *'the task of research is largely to determine the nature of the evidence needed and to design methods by which to discover and measure this other evidence'*. In essence, an inductive approach reflects upon past experiences and uses the normalisation of abstract concepts, theories and generalisations to explain past experience and predict future events (Gill and Johnson 1991).

Gill and Johnson (2002) define the **deductive** approach as entailing the development of a conceptual and theoretical structure prior to its testing through empirical observation. Saunders *et al.* (2000) notes that deduction involves the development of a theory, that is then subjected to rigorous testing. Cooper and Emory (1995:26) explain that a deductive approach refers to an approach where relationships are established between reasons and conclusions, by way of empirical study.

The generation of the theoretical green supply chain management pressure/response model presented in Chapter 3 is arguably inductive, since it is based on the examination of established theory, qualitative secondary case examples and published studies. The testing of this model through the research instrument adopts a deductive approach. The deductive testing follows the five sequential steps outlined by Robson (1993:19) detailed below:

- Deducing a testable proposition about the relationship between two or more concepts;
- Expressing the propositions in operational terms, proposing a relationship between two or more specific variables;
- Testing the operational proposition through empirical testing;
- Examining the specific outcome of the enquiry to confirm theory or propose modifications; and
- Modifying theory in light of the findings of empirical enquiry if necessary.

4.4.1 Intelligence Gathering and Literature Review

Saunders *et al.* (2000, 2003) note that the literature review process can be likened to a series of upward spirals, whereby the initial definition of the research objectives results in the definition of parameters, followed by the generation of keywords used to conduct a literature search. This process is repeated in light of a redefinition of the parameters from each previous cycle. This tightening focus of the research topic during the lifespan of the project results in a critical literature review. Since management research tends to make use of material from a variety of disciplines, the literature search needs to include a wide variety of sources that are discipline specific, or interdisciplinary.

Since management research can be both applied (i.e. with a practical action based focus) or academic (i.e. the generation of theory) where '*every decision we take is based on theory - that certain consequences will flow from the decisions*' (Saunders *et al.* 1997:24) any source of literature that reports such decision making is useful in the development and testing of theory. Gill and Johnson (2002) define theory as a formulation regarding the cause and effect relationships between two or more variables, which may or may not have been tested. Therefore, it is not just academic material that has relevance in management research but any applied research, including reports, company documents and other forms of communication that may contain relevant information.

Phillips and Pugh (1994, 2000) do distinguish between 'research' and what they call 'intelligence gathering'. This latter idea is the collection of facts for later analysis during the 'research' process. Thus, such facts can be communicated not only in the traditional scholarly works but also in other media. However the 'quality' of information available via these media must be identified, or compensated for, in the research process. The method(s) of analysis need to take account of the fact that non-traditional theory reporting (i.e. non-academic) is not necessarily designed to be easily 'analysed' and may reflect a specific bias of the author(s).

Howard and Sharp (1996) identify two main reasons for reviewing literature, firstly to generate and refine research ideas, and secondly as a fundamental part of the research project process. The intelligence gathering discussed by Phillips and Pugh (1994) is initially descriptive, generating 'what' questions. Some of these questions go beyond description and require analysis and result in a need to look for *'explanations, relationships, comparisons, predictions, generalisations and theories'* (Phillips and Pugh 1994:47). Authors such as Janowicz (1995) stress that knowledge gained during the generation, or testing, of theory is only significant to the extent it is the same or different from other peoples' work. This gathering of information and its subsequent analysis during the critical literature review phase is essential in setting the context of the research questions and objectives within the wider knowledge environment.

4.4.2 Theory Building: Literature Review and Analysis

As Flynn *et al.* (1990) note, the establishment of a theoretical foundation is critical for all scientific research. In order to identify the relevant literature for this thesis it was necessary to undertake an initial literature scoping exercise. The two main antecedent areas of literature that contribute to the thesis topic are the 'business /management' and 'environmental (ism)' areas of research. These are extremely broad areas of study and therefore a framework to identify relevant publications was necessary, illustrated in figure 4.3. The literature that forms the basis of this thesis (presented in Chapter 2 and Appendix 1.1) was identified either during this initial overview phase or during the subsequent targeted literature search[1]. The targeted literature search used the electronic and paper based search engines, conference proceedings, key literature reference lists and relevant journals, to identify material relevant to the thesis topic. Case studies were gathered from green business support literature material, trade publications, journals and company reports. Secondary sources of information, articles, case studies and reports,

[1] Appendix 2 presents an introductory overview of environmentalism in business, for readers unfamiliar with this topic.

that detailed the use of any aspect of supply chain management practices to green the organisation in question, or its upstream or downstream activities, were identified and analysed. The analysis of these is detailed in chapter 3 and the full details of each case presented in Appendix 3.

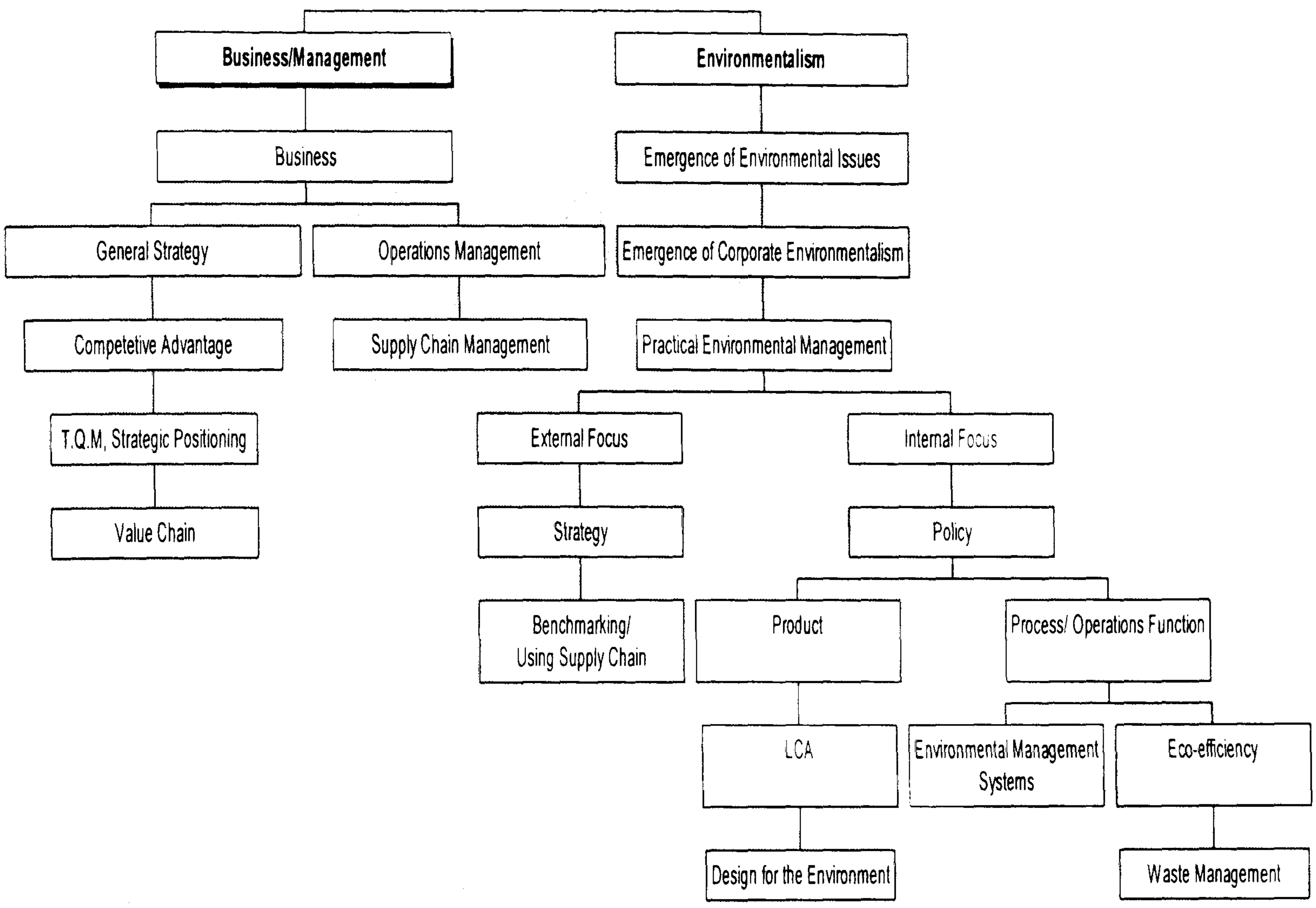


Figure 4.3: Overview of the literature scoping process.

4.5 Research Process Frameworks

The decisions associated with problem identification, what makes a suitable research topic for the proposed outcome and determination of inductive or deductive mode are the preliminary steps to the actual research effort and these decisions are shaped by the philosophical position adopted (Buckley *et al.* 1976). The research framework encapsulates the entire research process that ultimately leads to the adoption of a specific data collection technique(s), for instance the Saunders *et al.* (2000) framework presented previously in Figure 4.1, and a similar framework proposed by Buckley *et al.* (1976), which presenting a systematic method for designing and conducting research (Figure 4.4).

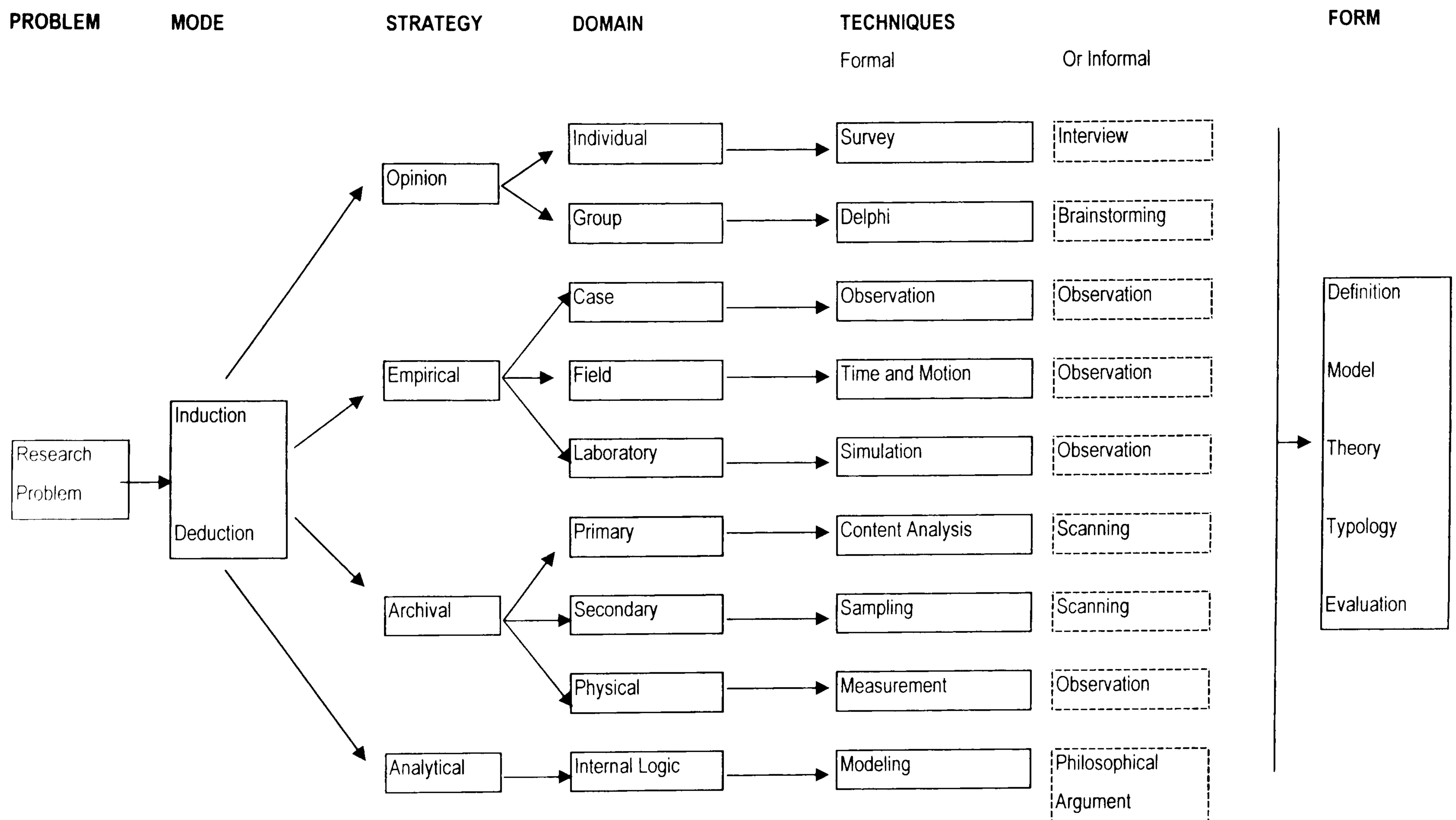


Figure 4.4: The research process framework, Gallear (1999) adapted from Buckley *et al.* (1976)

The Buckley *et al.* (1976) framework proposes that once the research problem is identified, five decisions/judgements need to be resolved before the data collection stage can begin (Fig. 4.4). These decisions relate to:

- Choice of mode of study (the decision regarding inductive or deductive research discussed previously);
- Choice of one or more research strategy;
- Choice of research domain;
- Decision regarding formal or informal techniques; and
- Choice of actual methods and techniques to be used.

Gallear (1999:177) adds a sixth dimension to the Buckley *et al.* (1976) framework, focussing on the *form* of the desired outcome, reflecting the form of the contribution to knowledge made by the research study. The next section examines the stages of the Gallear (1999) framework in light of the methodology adopted for this thesis

4.5.1 Research Strategy and Domain[2]

Research strategy refers to the process by which data is found and analysed and the strategy adopted shapes the nature of the source of data and the specific methods used for collecting it. In Buckley *et al.* (1976) and discussed in detail in Gallear (1999), the exclusion of possible strategies and domains (source of the data and environment) in many ways determines the shape of the research. In this study the research problem, (to examine the operational framework of green supply chain management), suggests an *opinion* based strategy, where the views of practioners are examined to test a theoretical model of green supply chain management.

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2 The classifications used in the Buckley *et al.* (1976) and Gallear (1999) models are used here but reference can also be made to the Saunders (2000, 2003) model (detailed in figure 4.1) Action research and grounded theory have been discussed elsewhere in this thesis and can be classed as empirical studies, as are experiments. Case studies may adopt a mix method approach, comprising of archival, opinion or empirical research.

The *analytical* strategy is excluded as this relies upon the use of 'internal logic' where no explicit reference to external data sources is necessary (Buckley *et al.* 1976). The *archival approach* is concerned with the examination of documented facts. Whilst the generation of the theoretical model takes this approach, it is inappropriate for the actual testing of the green supply chain management pressure/response model proposed in chapter 3. This is because the archival research is mainly historical and the information needed to test this model would not be present in all the documents examined.

The *empirical approach* is defined as *'something which originates in or is based on observation or experience'* (Buckley *et al.* 1976:24). Personal observation by the researcher is impractical due to time limitations and the need for a large sample to test the theoretical model. Therefore a form of empirical research is undertaken, whereby the *opinions* of informed research subjects are gathered. Whilst there are cited weaknesses in the opinion approach, which are mainly focussed on the argument that opinions are non-factual and therefore cannot reflect reality, if the research design minimises the methodological weaknesses of this approach then arguably such research can reflect reality[3].

The nature of the research problem and the need to test the green supply chain pressure/response model suggest that the domain should be that of individual respondents from different organisations. Whilst a group approach is possible finding a sufficient large cross-sectoral group available at the same time, and having to travel to one location is very problematic. The statistical exploration of this model requires a large sample set so that the findings might be generalised. Therefore, the individual survey method offers the most appropriate option to gather opinions from a very large group efficiently.

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3 The weaknesses associated with opinion research and strategies to reduce these are discussed in section 4.6 and chapter 5

4.5.2 Triangulation of Data

Multiple sources of evidence are important when attempting to understand research findings (Gummesson 1988; Yin 1998). As Saunders *et al.* (2000) note a multi-method approach can often be beneficial, combining qualitative and quantitative data, primary and secondary data. This allows 'triangulation' whereby collecting data from different sources allows verification of the information collected. Miller and Fiesen (1982) argue that triangulation enables concerns raised by the use of either quantitative or qualitative data to be dispelled. Figure 4.5 illustrates the use of triangulation of data sources in this thesis.

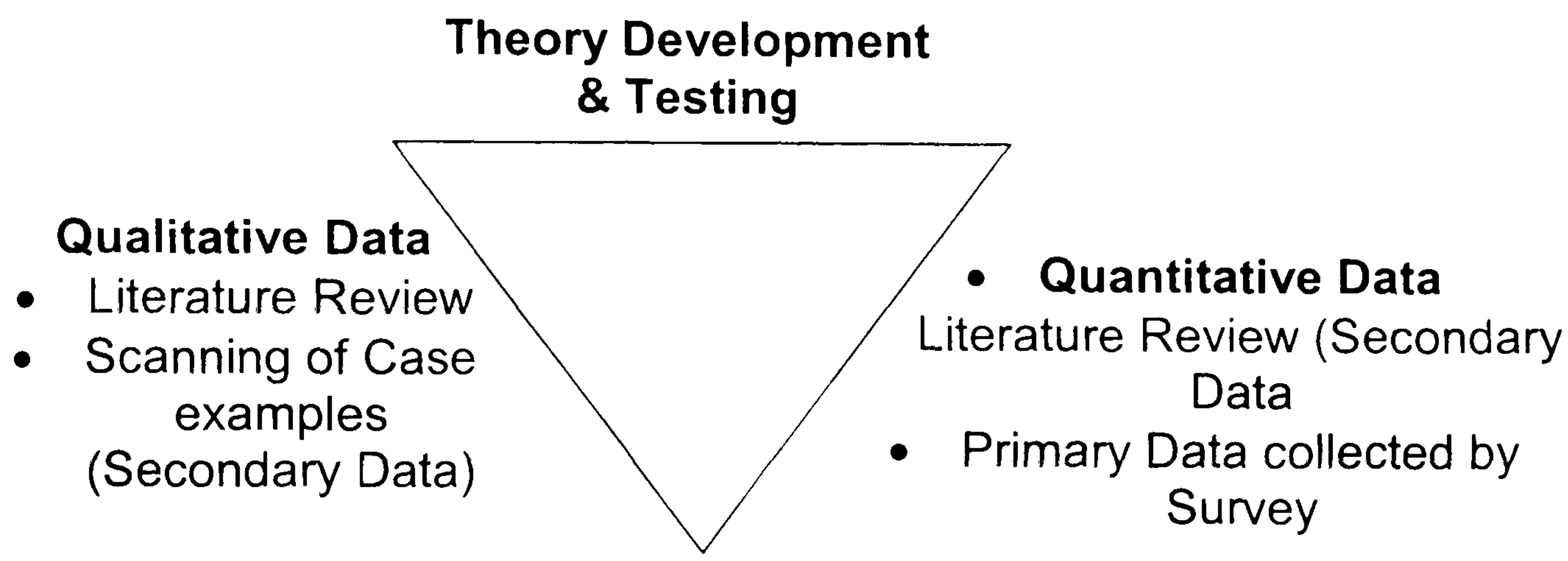

Figure 4.5: Triangulation of data collection process in this thesis (after Saunders *et al.* 2000)

The process of triangulation improves the credibility of the data collection process. Yet, Gummesson (1998) argues it is not important to distinguish between field study data and the study of documents. It is the consensus of these information sources that is important for the researcher. Thus, the secondary data provided by the case examples in Appendix 3, and analysed in Chapter 3 is important in building theory and in the triangulation process.

4.6 Research Techniques

The previous discussion surrounding research design and philosophy indicates that the opinion research strategy is the most appropriate technique for the primary data collection in this thesis. The research objectives in chapter one clearly show the need for a cross-sectoral large-scale assessment of green supply chain management practices. The critique of the current literature also presented in chapter one suggests the need to move away from single case examples or anecdotal research, suggesting a quantitative, opinion/empirical research approach. However, the model of green supply chain management pressures and management practices utilises previous work in this field that reflects many of the other methods, such as case studies, action research, grounded theory and interviews, not used in the deductive testing phase. An interview research methodology is discounted due to the need to collect a large amount of data, and a survey/questionnaire approach identified as the most appropriate research technique.

Buckley *et al.* (1976) notes that each research technique that is available to a researcher has it's strengths and weaknesses. In the case of opinion research the key strengths are that:

- It is best suited to research on attitudes, impressions and beliefs;
- It is best suited to futures research, where opinion must substitute for the non-reality;
- Large samples can be drawn, which facilitates inference to large populations;
- It is the easiest methodology to devise and administer, usually involving questionnaires and interviews; and
- It lends itself to data analysis via a wide range of standard statistical procedures.

May (1997:83) state that surveys are seen to utilise a *'methodology with a logical similarity to that used by physical scientists'*. The effectiveness of any methodological approach is evaluated by its internal validity, external validity and reliability (Gill and Johnson 2002). Reliability is discussed by Yin (1994) who states that if a later investigator follows exactly the same procedures as described by the first, the results of the second investigation should mirror that of the first. Gill and Johnson (2002) suggest that by using highly structured questionnaires to gather data in a form that can be analysed quantitatively, survey based research is easily replicable and hence reliable.

Surveys and opinion research approach do receive criticism. May (1997:104) states that the survey approach *'rules out the possibility of understanding the process by which people come to adopt particular values or behaviours'*. However, the grounding of the research study in theory can lessen this criticism. In the research instrument adopted for this thesis, the green supply chain pressure/response model is grounded in theory, as discussed in chapter 3. Yin (1994) notes that surveys are appropriate for 'descriptive' research which Robson (1993:3) defines as *'an accurate profile of persons, events or situations'*. Descriptive research allows the collection of large amounts of data from a large sample of the population at an economical cost.

Buckley *et al.* (1976) details the common criticisms of opinion research as:

- Non-factual nature of opinions failing to come to grips with reality;
- Methodological biases in the prior selection of questions and sample set;
- Systematic biases in the way that people respond to questions;
- Systematic bias inherent in the administration of the instrument, sampling errors, role of the interviewee and reactions of those being interviewed;
- Opinions are unstable over time making replication difficult; and
- Difficult to capture group dynamics.

However, in this thesis the focus is partly on green supply chain management practices, targeted at an audience that are either Managers or CEO's experienced in environmental or supply chain matters. This means that a greater approximation to the 'truth' is expected in the answers given. Their managerial position in the organisation also arguably gives them a strategic overview allowing the questions regarding the pressures driving the operational activity to be answered from an 'informed' position.

The involvement of the CIPS and the confidential nature of the questionnaire should also improve the quality of response. The rigorous pre-testing phase is designed to reduce bias. In addition, the postal nature of the questionnaire means that respondents will not be influenced by an interviewer or reactions to one. Whilst opinions may alter over time, or reflect the view of that particular person, the focus on actual 'actions taken', and careful targeting of respondents may decrease the influence of this.

4.7 Conclusion

In conclusion, this thesis adopts a positivist philosophy and two stages of inquiry. Firstly, the inductive modelling of the pressure/ operational response framework of green supply chain management, based on the literature review and basic content scanning of a series of published 'snapshots' of current green supply chain practices in a range of organisations. This inductive model is then tested deductively using opinion research, via administration of a survey to a cross-sectoral sample of members of the CIPS, who each represent an individual organisation.

Figure 4.6 highlights the research framework adopted in this thesis, using the research framework of Buckley *et al.* (1976). This process can be summarised as:

(i) Generation of Model → Archival → Secondary → Scanning

(ii) Testing of Model → Opinion → Individual → Survey

The next chapter examines in more detail the methodological process of designing, implementing and analysing the research instrument and data collected.

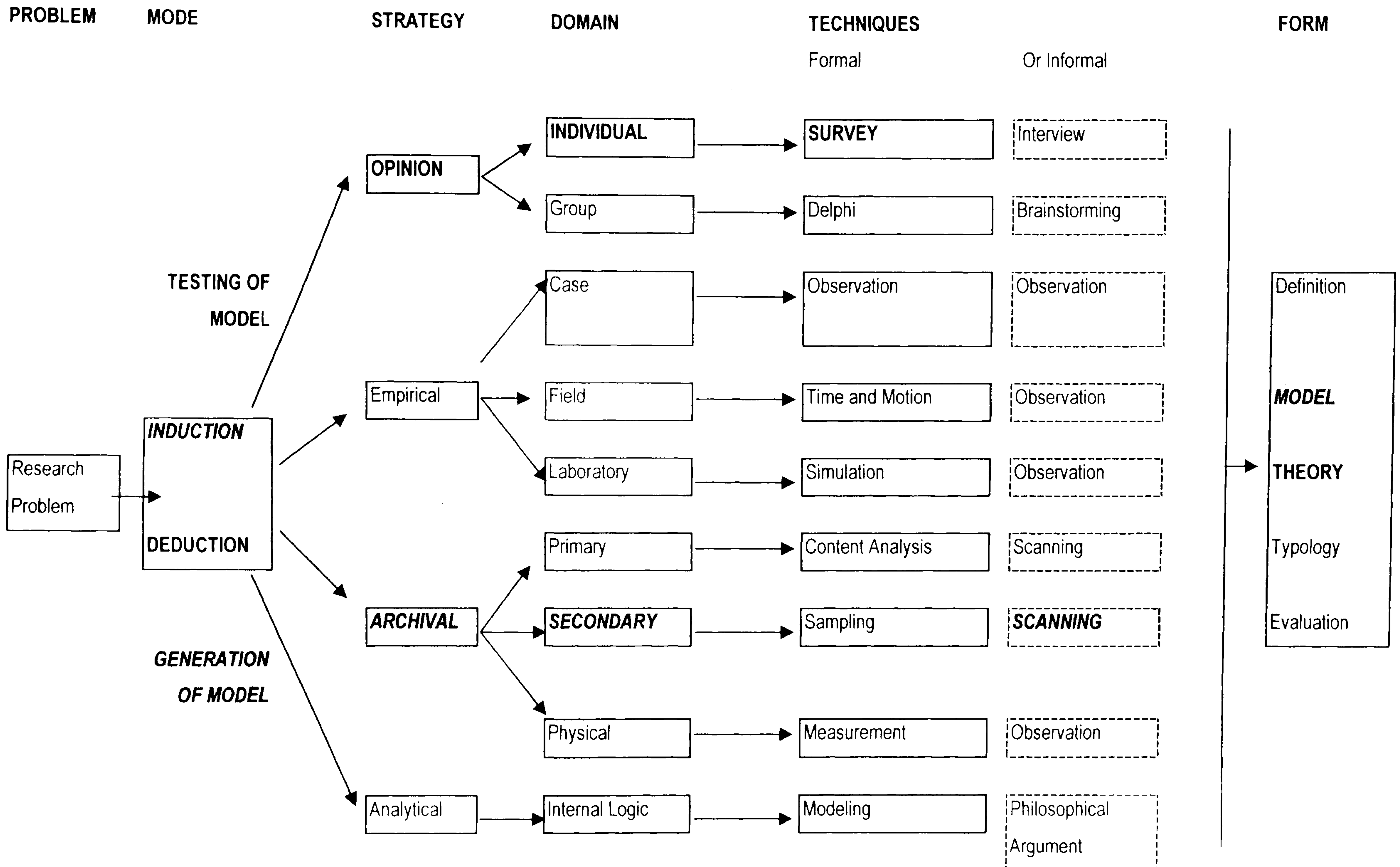

Figure 4.6: A summary of the research framework adopted for this thesis.

CHAPTER 5: THE METHODOLOGICAL PROCESS – QUESTIONNAIRE DESIGN, IMPLEMENTATION AND ANALYSIS

5.1 Introduction

In the previous chapter (section 4.7) two stages are identified for the methodology adopted in this study.

(i) Generation of the green supply chain pressure response model

(ii) Statistical exploration and testing of this model

The generation of the green supply chain management model occurs through literature review, scanning of secondary case material and analysis of previous empirical studies. This material is presented in the literature review in chapter 2 and the development of the model in chapter 3.

This chapter focuses upon the 'testing' of this model through the design and implementation of an opinion based survey research instrument, identified as the most appropriate research technique in chapter 4 (section 4.6). This chapter examines in detail the design and analysis of the research instrument used in this thesis and this is summarized in figure 5.1.

In addition, readers are directed towards appendices 4 and 9, which contain additional information on the sampling framework and the quantitative data analysis.

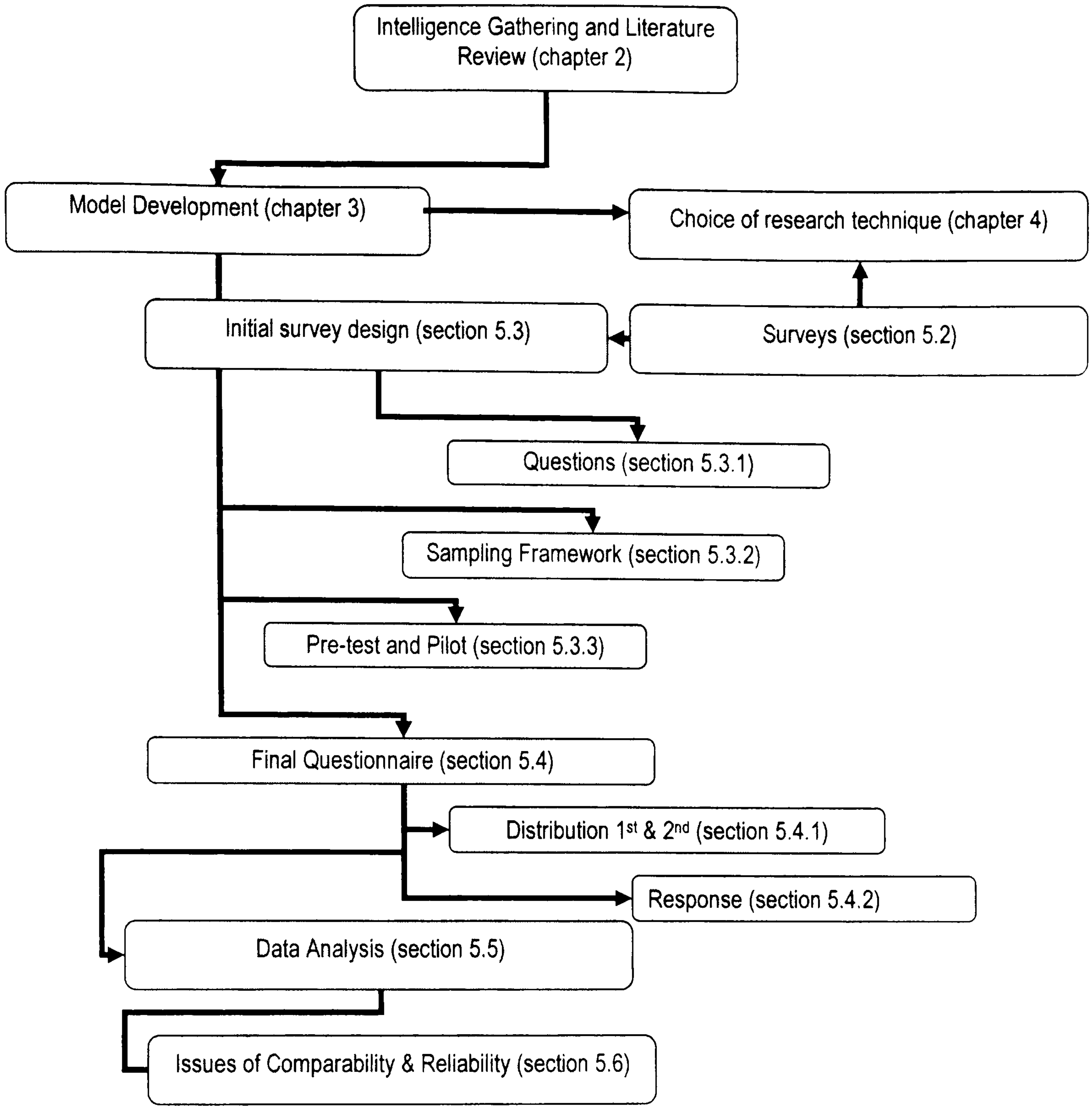

Figure 5.1: Overview of the methodological process

5.2 Survey Research

Surveys refer to a method of data collection that utilise questionnaires or interview techniques for recording the behaviour of respondents. As Ghuari and Gronhaug (2002) note, surveys are an effective tool to get opinions, attitudes, descriptions and investigate cause and effect relationships. Since this thesis statistically examines the pressure/response model of green supply chain management, data is needed that is suitable for quantitative analysis.

Detailed guidance in developing survey interview protocols and mail/internet based questionnaires is provided by most business research textbooks, examples include Frazer and Lawley (2000), Gill and Johnson (2002), Ghauri and Gronhaug (2002), and Saunders *et al* (2000). Forza (2002) provides a state of the art evaluation of survey research in operations management and identifies three types of survey research.

- *Exploratory survey research* that takes place during the early research into a phenomenon with the objective of gaining preliminary insight into a topic. Normally there is no model, with the focus on understanding and measuring various concepts of interest.
- *Descriptive survey research* aimed at understanding the relevance of a certain phenomenon and describing the distribution of this phenomenon through a population.
- *Confirmatory (or theory testing or explanatory) survey research* that takes place when knowledge of a phenomenon has been articulated in a theoretical form using well defined concepts, models and propositions (Forza 2002)

As discussed in section 1.3.2, green supply chain management research is arguably in a development stage, consisting mainly of descriptive surveys and anecdotal case examples. However, there are a number of confirmatory survey studies (for example Carter and Carter 1998; Carter *et al.* 2000; Carter and Jennings 2004) but these are focused on a single sector or one aspect of green supply chain management such as green purchasing. Section 1.3 establishes the need for additional theory development, replication and synthesis of green supply chain management research. The findings presented in this study are descriptive (chapters 6), exploratory (chapters 7, 8 and 9) and confirmatory (chapter 10).

Questionnaires can be communicated to potential respondents through four different medium; through the mail, personally administered, through the telephone and the Internet (Frazer and Lawley 2000:3). A comparison of these different types of methods is presented in table 5.1.

Table 5.1: Comparison of questionnaire communication methods (Frazer and Lawley 2000)

Criteria	*Mail*	*Personal*	*Telephone*	*Internet*
Cost	Low	High	Moderate	Very Low
Speed of data collection	Slow	Intermediate	Immediate	Fast
Ability to reach different geographical areas	High	Very Low	Medium	Very High
Length	Long 4-6 pages	Long 30-60 minutes	Medium 10-30 minutes	Long 4-12 pages
Question complexity	Simple to moderate	Simple to complex	Simple only	Simple to moderate
Hard to recall data available	Good	Poor	Moderate	Good
Respondent Anonymity	Possible	Not possible	Not possible	Possible
Rapport with respondents	None	High	Moderate	None
Interviewer Bias	None	High	Medium	None
Need for interviewer supervision	No	Yes	Yes	No
Response Rate	Low	Very High	Moderate	Moderate

In order to statistically test the model of green supply chain management a diverse geographical sample is preferred, which suggests Internet or postal questionnaires. A large-scale study should also provide a suitable number of responses for quantitative data analysis, which raise issues of cost. In fact, Bourque and Fielder (1995:9) suggest that a questionnaire administered by mail costs 50% less than one administered by telephone and 75% less than one administered by personal interview.

The use of the CIPS database facilitates the use of postal surveys because the database has full postal information, but not necessarily all email addresses. Secondly, this database is confidential and therefore all communication was sent via the CIPS office and staff, precluding the use of telephone and personal interviews.

5.3 Initial Questionnaire Design

In the design of the postal questionnaire a range of questions are used to measure aspects of green supply chain management. These questions are based on the literature reviewed in chapter 2 and the model developed in chapter 3. The first decision involves the details of the questions to be used (discussed in section 5.3.1). The researcher then decides on the sampling framework for the main study (discussed in section 5.3.2) and the initial version of the questionnaire is pre tested and piloted (section 5.3.3).

5.3.1 Deciding on the Questions

Postal questions can either contain closed (primarily quantitative) or open questions (primarily qualitative). It was decided that primarily closed questions would be the most appropriate to ensure comparability of data collected and allow the data to be quantitatively tested. A small number of open questions were also included to gain additional in-depth data, but as the main focus in the research instrument was on developing empirically valid constructs and relationships, open questions were kept to an absolute minimum.

The questionnaire used a mixture of scaled questions (based on the Likert scale), ratio scales (such as number of employees) and 'yes/no/intend to' questions for specific management practices. The questions related to pressures were opinion based, and difficult to quantify but the use of the Likert scale approach allowed strength of opinion to be assessed[1]. The questions associated with management practises focused on whether a particular action occurred or not (or whether this action may occur in the future) and so adopted the 'yes/no/intend' to approach[2].

The type of data collected by the research instrument is categorised as ordinal, nominal, or interval/ratio. The type of data determines the nature of the statistical tests used in later analysis (explored further in appendix 9)

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1 Similar studies that assess strength of 'environmental' opinion also used Likert scales e.g. Baylis *et al.* 1998a, 1998b, 1998c; Ghobadian *et al.* 2001; Lamming and Hampson 1996; Min and Galle 1997; Murphy *et al.* 1994, 1995, 1996.

2 Bowen (2001b) recommends that since the focus is on actual implementation of management practices the choices of yes/no presents better face and construct validity. Adding the 'intend to' choice avoids the pitfalls of socially responsible responses. In this study the statistical analysis of environmental actions is based on 'yes' responses only, which allows those stating aspirational aims of 'intend to' to be removed from the analysis.

Each question or group of constructs is designed to investigate a range of 'concepts'. A concept may comprise of underlying complex dimensions and this concept is normally articulated in the first instance by examining previous theoretical work (Bryman and Cramer 2001). Often the researcher develops a selection of constructs to search for indicators of each of the possible dimensions of a concept. These constructs may form an overall scale comprising of all indicators relative to all dimensions, or separate scales formulated for each dimension (adapted from Bryman and Cramer 2001: 61)[3].

Where a concept is operationally defined and a measure of it proposed, then the measurement device should be reliable and valid. Reliability refers to the consistency of measurement, whilst validity refers to the accuracy of the measurement process (Gill and Johnson 2002).

External reliability can be assessed by testing and then re-testing the same subject(s). However, such tests cannot be too close together or a recalled memory of previous responses may affect the results. Correspondingly, this re-test should not be after a significant change in circumstances, or after too long a time period, else other external factors may influence the results (Bryman and Cramer 2001). In this research, external reliability is not assessed by a re-test due to practical limitations. In addition, re-tests are not a valid option in this research due to the anonymous nature of the database used, which means that respondents cannot be individually identified unless they volunteer personal information.

Another option that can be used to assess external reliability of data is to send the same questionnaire to multiple respondents within the same organisation and compare the results (for example Carter and Dresner 2001). Since the CIPS database details individual members, there was no guarantee that

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3 Factor analysis can be used to check whether constructs measuring a concept are associated, or to identify the number of dimensions that the constructs measure. If two or more factors are extracted then the items measure a number of dimensions. The development of scales to measure each of the elements of the green supply chain pressure/response model from such constructs is discussed in appendix 9

multiple members would be available from all institutions, although this was likely as discussed in section 5.3.3. More importantly, the selection of the highest ranking manager (or environmental manager) aimed to find the most appropriate person to complete the questionnaire. Therefore, it may be that a second person in the organisation would simply send the questionnaire to the person who received the original questionnaire. Another option is to validate the information collected from the questionnaire by comparing it with publicly reported data (for instance Klassen and Whybark 1999 who use the EPA reported TRI pollution data). In the case of reported measures, such as financial performance, this might be possible if the respondents were not anonymous. However, public disclosure of the all information needed is extremely rare, especially for a wide cross sectoral sample. External reporting of environmental information is not compulsory in the UK, as it is for TRI emissions data in the USA.

Therefore, in this research the focus is on the assessment of internal reliability, as it is with many business and management research studies (Gill and Johnson 2002). None of the previous empirical research studies in green supply chain management identified in chapter 1 (see table 1.1) assess external reliability – only internal reliability. Internal reliability is important when developing multiple construct scales and is typically assessed using either (1) split half reliability or (2) Cronbach's alpha and in both cases a value of 0.8+ is typically accepted as reliable (Bryman and Cramer 2001). It is normal to calculate reliability estimates for each of the constituent dimensions of a concept rather than for the measure as a whole. In chapters 7, 8 and 9, Cronbach's alpha is used to confirm internal reliability.

Validity refers to the extent to which a scale encoded into a set of questions actually measures the variable for which it is intended. Gill and Johnson (2002) discuss aspects of validity and state that the only way to assess the validity of such measurement devices is to evaluate the results against some other measure or criteria that have previously demonstrated their validity. For instance, questions can be used that have been previously used in other research studies, or are grounded in the prior literature (Gill and Johnson

2002; Smith 1975). Where possible the use of previously tested questions is adopted in this research (see table 5.2).

Table 5.2: Use of validated questions and theory in final version of research instrument

Question Number in Final Questionnaire & Focus	**Original Reference** (References in **Bold** use identical or adapted questions)
8a – importance of environmental issues	**Murphy *et al.* 1996**
8b – importance of ethical issues	Adapted from **Murphy *et al.* 1996**
9 – will importance change over time	**Murphy *et al.* 1996**
10- departments managing environmental issues	Adapted from **Murphy *et al.* 1995**
12- environmental policy	**Murphy *et al.* 1996**
13- length of time of policy	Adapted from **Murphy *et al.*, 1996**
14 – Drivers of environmental management	Adapted from **Hall (2000), Murphy *et al.* (1996),** and literature review especially section 3.3 (particular reference to : Berry and Rondinelli (1998), Carter and Ellram (1998), Elwood and Case (2000), Green *et al.* (1996), IM (1998), Lanoie and Tanguay (2000) Min and Galle (1997))
17 – critical dependency on suppliers	**Hall (2000)**
20 – operational practices	Literature review in chapter 2 and case examples in appendix 3
23 – environmental criteria for suppliers	**Carter and Carter 1998**
24 – supplier criteria	Literature review in chapter 2 and case examples in appendix 3
27 – critical dependency on suppliers	Adapted from question 17
29 – obstacles to green supply	Adapted from **Min and Galle (1997), Murphy *et al.* (1995), Carter and Carter (1998).**
30 - manufacturing	Literature review in chapter 2 and case examples in appendix 3

5.3.2 Sampling Framework

As discussed in chapter 1 (section 1.6), this research was undertaken in association with the CIPS and using their database of members. One of the primary advantages of using the CIPS database is the possibility to reach a cross-sectoral sample. Anderson (1991) suggests that the generation of theory requires the most 'different' cases as opposed to the most similar. One of the major criticisms of previous green supply chain management expressed in chapter 1 (section 1.3.4) is the focus of the majority of studies on a limited number of sectors (such as the work of Carter and Carter 1998; Carter *et al.* 1998; Carter and Jennings 2002, 2004; Murphy *et al.* 1994, 1995, 1996; and Murphy and Poist 2000, 2003).

The selection of respondents was carefully targeted through selection of members from the database, to reach the 'right' person in the organisation to receive the questionnaire as recommended by New *et al.* (2002). The CIPS database identifies seven hierarchical job ranks. Only the upper 2 levels of management (or those with a job description that included an environmental role) were used, and multiple entries from organisations removed by selecting the highest ranking, or environmental, member of staff. This selection process arguably leads to a better targeting process in the data collection phase. The seniority and experience of the selected CIPS member arguably improves their ability to answer on behalf of their organisation. This approach mirrors that of previous studies that used members of a professional body, for example USA based: National Association of Purchasing Managers[4]; Institute for Supply Management[5]; and Council of Logistics[6] .

Ryan (1995:159) notes that '*the advantages of postal questionnaires can be nullified if the response rate is too small and unrepresentative*'. Appendix 4 details a statistical calculation for the minimum sample size required for the initial distribution of the questionnaire (1100) and the number of eligible organisations from the CIPS database (1457) from a total membership of the CIPS of 25800 individual members. The targeted respondents were all CEOs, Senior Managers or Environmental Managers[7], from 1457 different organisations. Specifically, the target respondents were in the upper two levels of senior management (from a possible seven), or had a job skill designation that included 'environment', and were from an organisation with more than 10 employees.

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4 Carter and Carter 1998; Carter *et al.* 1998, 2000; Min and Galle 1997

5 Carter and Jennings 2004

6 Murphy *et al.* 1994, 1995, 1996; Murphy and Poist 2000, 2003

7 The suite of Carter and Murphy studies discussed in the previous paragraph also targeted

Limitations in the use of the CIPS database are detailed in section 5.6 and in the concluding chapter (11). The sample selected was representative of the 'population' of the CIPS. However, in common with the databases of the CLM[8], ISM, NAPM, the CIPS database is biased towards larger organisations. Given that the aim of the study is to test the green supply chain model to establish relationships that are valid in a range of types of organisations then the 'mixed' nature of the database is not a major flaw. The inherent bias within the CIPS database is also compensated for by examining a variety of demographic characteristics, such as sector or size, to see if they moderated the green supply chain model and its relationships.

5.3.3 Pre-test and Piloting

After the design of the initial questionnaire and the identification of a suitable sample, the questionnaire needs to be pre-tested and piloted to improve the quality of the final questionnaire. The pilot process selects a small number of respondents from the original sample set to examine how the questionnaire might be received by the entire sample and identify any potential problems.

The process and effectiveness of pre-testing a research questionnaire is reviewed in detail by Reynolds *et al.* (1993). Pre-testing and a pilot study involve submitting the questionnaire to colleagues, industry experts and target groups (Forza 2002). Checking a questionnaire with colleagues will identify whether the questionnaire accomplishes the study objectives. Industry experts identify missing or overtly obvious questions. The target group pilot study allows the researcher to gain feedback on issues that might affect the completion of the final questionnaire when it is distributed to the final sample (after Dillmann 1978). Pre-testing and a pilot study stage were used to develop the final questionnaire (after Reynolds *et al.* 1993).

The first stage of the pre-testing of the questionnaire was the detailed

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upper or middle management, purchasing or logistics managers.

feedback from the academic expert group[9]. This involved circulating the first draft of the questionnaire, as well as the objectives and inductive model to a team of academic experts. This group consisted of university academics experienced in either survey research and/or supply chain management. In light of the feedback the questionnaire was redesigned.

The questionnaire was then circulated to a 'focus group' of external experts along with the research objectives. This expert panel comprised of the sixteen members of the '*Environmental Special Interest Group'* of the CIPS, based in Construction (1)[10], National Research Organisation (1), NHS (2), Public Utilities (2) Manufacturing (1), Public Sector (2), External Academic (2), NGO (1), Consultant (1) Service (3). These focus group participants represented a cross section of the CIPS database (after Reynolds *et al.* 1993). Verbal, email and written feedback was received from this group individually and the questionnaire redesigned accordingly to produce the Pilot questionnaire (detailed in Appendix 7).

Ghauri and Gronhaug (2002) state that a questionnaire should go through a pre-test/pilot of between 3 – 5 companies or respondents. Although most pre-test samples are small (Reynolds *et al.* 1993) a representative sample should be used that covers all the sub-groups in the target population (Green *et al.* 1988).The purpose of a pilot study is defined by Saunders *et al.* (2000) as a process that refines the questionnaire so that the final respondents will understand the questions and establishing that the results can be understood by the researcher. Ambiguous questions can be clarified and the average length of time the questionnaire will take to be completed identified. In addition, Bell (1999) suggests that in the case of self-administered questionnaires additional information can be obtained by giving respondents a further short questionnaire that establishes:

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8 See Glossary for full details

9 Four research active Middlesex staff examined the questionnaire: a Professor in Operations Management and three Senior Lecturers experienced in Market Research, Supply Chain Management and Environmental Issues.

10 (number of respondents selected)

- How long the questionnaire took to complete;
- The clarity of instructions;
- Unclear or ambiguous questions; and
- Whether there were any omissions.

The sample selected for the pilot study came from the CIPS database, selected by the CIPS in association with the researcher. The pilot study group were called personally by the Practice Manager [11] of the CIPS to explain the purpose of the pilot study. Sixteen organisations were chosen to represent a cross-section of the target population (after Green *et al.* 1988)[12]. It is not possible to compare the proportion of the original 1457 targeted respondents in each sector with the complete CIPS database of 25800 members. However, it should be considered that these 1457 organisations have multiple members on the database and in fact there were 2794 members identified in the upper two levels of management in the original database selection, before duplicates were removed. Therefore, given that lower job ranks are likely to have larger numbers of CIPS members it is arguably valid to suggest that the 1457 organisations finally targeted, represent a high proportion of the organisations present in the CIPS database.

In addition, to the pilot questionnaire a second, shorter, open-ended questionnaire was used to gain written feedback on the questions and structure, (after Bell 1999), as illustrated in appendix 6. Feedback was returned from ten of the pilots study representatives and this is summarised in table 5.3. Names of the respondents are confidential although some respondents did give their details.

Nine pilot questionnaires were returned, of which eight had feedback cover sheets. A tenth respondent indicated that he felt the questions were not really

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[11] C. Kockelbergh, Practice Manager of the Chartered Institute of Purchasing and Supply

[12] The sectoral composition of the 1457 organisations is detailed later in this chapter (see table 5.5). The composition of the focus group is representative of the larger CIPS sample and the pilot group represented each of the major group of respondents (private, public, manufacturing and service).

relevant to his company (a public/ service company) and therefore, he had not completed it. However, two other public service organisations (and two private service organisations) did return feedback.

Table 5.3: Synopsis of pilot study feedback

Responses from each sectoral group	Public Service (2)	Private Service (2)	Private Manufacturing (3)	Construction (1)
Average Length time taken to complete	2.5 hours (3 hours & 2 hours)	27.5 minutes (30 & 25)	25 minutes (30, 20) No information given on one Another stopped after 30 mins.	None given
Ambiguous questions	Rather generic All made sense	32, 1 not a good fit	19, 3, 32	None given
Irrelevant questions	None	None	7	None given
Omissions	None	None of what recycling now	Relationship with HSE and or Environmental Agency Q4 should include global organisation; Q1 needs industrial technology section Should include copy of environmental policy	None given
Duplications	None	None	Requirements very detailed maybe outside remit of one person	None given

Of the nine completed pilot studies, two were public/service organisations (police and a local council), two were private/service companies consisting of a hotel and an upstream oil company, there was one response from a construction firm and four private/manufacturing companies comprising of machinery manufacture, aerospace manufacturing, confectionery manufacturing and packaging manufacture. With a small pilot study it is difficult to get a truly representative return. However, all the major sectoral groups in the original database sample are represented by the sample of returned pilot questionnaires.

Analysis of the feedback from the respondents suggested that the questionnaire was slightly too long for some respondents (especially those in the public/service sector). The complexity of the questionnaire was also a little off putting to some respondents. The questionnaire is designed for a cross sectional study and therefore needs to address a range of different conditions, and this can be complex and confusing to those from 'different' sectors. Therefore, it was decided that the questionnaire structure needed better 'routing' around sector specific questions (and a separate manufacturing section was created).

The pilot response rate of 56% was encouraging, suggesting that the role of the CIPS in the data collection process might increase the response rate and could be a factor in the main study.

5.4 Final Questionnaire Construction

The questionnaire was adapted to take on board the commentary from the pre-test and the pilot and sent to the CIPS sample identified in section 5.3.2. The final questionnaire was structured into the following sections:

(1) Company information – sector, relationship with market, general structure of company, number of employees, organisational structure, turnover

(2) Operating environment and environmental issues- role and importance of ethical and environmental issues and which functions were responsible for formulating environmental policy implementation and assessment of environmental performance

(3) Motivating factors for environmental management (variety of different types of pressures driving change)

(4) General information on purchasing and logistics – numbers of customers and suppliers, amount spend on purchasing and how critically dependent the organisations was on certain goods and services

(5) Environmental Supply and Management Practices – whether an organisation had been requested by an external party to make environmental changes, a series of 'green supply chain activities (clustered into subsections based on the inductive model in chapter 1) and a series of questions on supplier assessment and evaluation. Obstacles to green supply chain management were also investigated

(6) Manufacturing Questions – a series of questions on management

practices for manufacturing firms.

(7) Further information section

A copy of the final version of the questionnaire is provided in appendix 8

5.4.1 Questionnaire Distribution

This next section examines the distribution of the final version of the questionnaire to the 1457 organisations in the CIPS sample. This section also examines the final response rate, with non-response bias examined in more detail later in this study (section 5.6.2).

5.4.1.1 First Distribution

Each of the 1457 organisations was sent a copy of the questionnaire, addressed personally to the individual CIPS member accompanied by a covering letter. This covering letter, from a member of staff at the CIPS on their headed paper, explained the purpose of the study and urged their co-operation. A freepost return envelope was also included. The CIPS Members were also informed that the survey was taking place via an article in their members' magazine in the month preceding the questionnaire mailing. Questionnaires were returned to the CIPS and then forwarded to the researcher in chronological batches.

5.4.1.2 Second Distribution

The confidential nature of the CIPS database precluded direct contact by the researcher as part of a follow up procedure to improve response rates. However, an email was drafted and sent by the CIPS, using email addresses on their database, in December 2002. The email reminded members about completing the survey and requested that those who were not going to complete the survey to indicate their reasons. A small number of 'new' questionnaires were received (five) and all the other respondents to this second call identified the reasons why they had chosen not to complete the questionnaire (table 5.4).

Table 5.4 : Reasons given why questionnaire not completed

Reasons why questionnaire not returned	Number
Postal questionnaire returned to sender	7
Company does not respond to requests for information via surveys	6
Inconvenient to complete	11
Another person in organisation responded	4
Unsure of information needed	1
Undeliverable email	103
Inappropriate to company	6
Environmental issues are not an issue or are not considered	1
Total number of reasons why second call (and first) not responded to	*139*

5.4.2 Response

Of the total number of questionnaires distributed (1457) there were 149 usable responses, constituting a 10.2% response rate. In light of the results of table 5.4 this might be adjusted to 11.3%. Anecdotally, the representative at the CIPS reported this as a reasonable response rate. It should also be considered that the CIPS database is used for a number of commercial mailings and members are used to receiving questionnaires and mailings from them. The timing of the survey was designed not to 'clash' with other CIPS and commercial mailings that were due to be sent to members in the designated time period. However, most texts on surveys recommend aiming for more than a 25% response (Frazer and Lawley 2000; Forza 2002).

This unadjusted response rate of 10.2% is therefore relatively low. However, the total number of responses does provide a suitably large number of cases for statistical analysis. A number of the previous survey based studies discussed in the literature review have lower *absolute* numbers or similar response rates as indicated below:

- Autry *et al.* (2001) reports on 71 organisations in the USA (33.5% response rate);
- Carter *et al.* (1998) study uses 125 responses (25.3% response rate);
- Klassen and Whybark (1999) US study - 83 responses (27.5% response rate);
- Murphy *et al.* (1994, 1995, and 1996) studies - 133 responses (29.7%)

plus an additional 24 from the EU sample (24.7%) and 31 Canadian responses (24.7%) in Murphy and Poist (2000);

- Rao (2002) study in S.E. Asia reports a 10% response rate amongst 'leading edge' 14001 certified companies; and
- Zsidisin and Hendrick (1998) study a 12.5% response rate is reported for the UK sample, as part of a combined overall response rate between Germany, USA and UK of 14.3%.

Lohr (1999) argues it is the actual size of the population sampled that matters, rather than the proportion of the population that is sampled. In fact, Folz (1996:49) suggests that:

> *'as long as the population is relatively large the proportion of the population sampled does not have a big impact in precision, because it is the absolute size of the sample rather than the size of the sample fraction that determines precision'.*

Bentham and Mosely (1982:368) note that sample size is often a matter of judgement rather than statistically calculated targets, reflecting a compromise between what the survey needs to achieve and the resources available to achieve these needs.

Therefore, the response rate in this study represents a large number of UK organisations (149) and provides a suitable number of cases for a range of statistical tests. It should be borne in mind that this was not a study of 'leading edge' organisations, but a cross section of UK organisations of different levels of commitment, and practical responses to green supply chain management. Andersen (1991) claims that the *'most different cases'* as opposed to the *'most similar cases'* should be examined when the purpose is to develop general propositions. Yet, the approach of addressing a wider range of organisational sectors does present researchers with the problem of differing constraint on organisations and reasons why an organisation would not spend time on completing surveys. Preuss (2001) found a variety of reasons why companies would not respond to a request for data associated with financial constraints, time constraints and individual business reasons affecting only that particular company. Resource constraints are also a major factor affecting SMEs and lead to lower response rates in these size classes, which was why organisations of less than 10 employees were excluded from the sample selected from the CIPS database. In addition, other studies that used similar kinds of databases (Carter and Carter 1998; Carter *et al.* 1998, 2000; Min and Galle 1997; Murphy *et al.* 1994, 1995, 1996) all reported that the databases that they used were biased towards larger organisations.

Jobber and O'Reilly (1996) suggest a number of techniques used for postal surveys to increase response rates and suggest that prior notification and anonymity are important. A 'pre-survey' contact (after Saunders *et al.* 2000) is difficult in this study due to the restrictions imposed by the CIPS on access to confidential information on members. Therefore, an article was inserted in the CIPS magazine in the month the survey was sent out advising potential respondents of the existence of the study and urging their co-operation. The use of a covering letter from the CIPS and their logo on the main survey was used to encourage participation by members.

The second reminder by email was the only realistic option available given the constraints imposed by the use of the CIPS database, as it was not possible to identify the all the organisations that did/ did not respond. Alternative strategies that might be adopted if the non-respondents can be identified are to mail a slimmed down version of the questionnaire to non-respondents and compare the answers (Carter and Jennings 2004), or telephone non-respondents and ask the answers to a small number of questions (Prendergast and Pitt 1996). The purpose of this comparison is to investigate whether there is any non-response bias present in the results (see section 5.6.2 for a discussion of this in relation to this research).

5.5 Data Preparation for Analysis

The questionnaires were collected at the CIPS office, to ensure a better response rate by linking the survey clearly with the respondents own professional body, and were then forwarded to the researcher in batches. The returned questionnaires were numbered and entered into the SPSS statistical package (version 11) using a coding matrix. A review of all the questionnaires was undertaken to identify any data 'cleaning' that need to take place and if there were any ambiguous comments/ indicated on each questionnaire.

Appendix 9 presents an overview of the quantitative analysis techniques that are used in this thesis. The nature of each variable and its resultant distribution (especially whether it is normally distributed) will affect the types of quantitative analysis that can be used. The starting point within any data analysis is to examine the descriptive elements of the findings, using measures such as the mean. Tests of difference can then be used to identify whether there are significant differences between groups clustered according to some classifying criteria. In addition, to the tests of difference there are a range of statistical techniques that assess relationships between two or more variables, so allowing some form of prediction whereby knowledge of one variable allows the prediction of another. Data can also be simplified through processes such as factor analysis (FA), and principal component analysis (PCA) to allow large amounts of data to be transformed into variables that lend themselves more appropriately to different quantitative analysis techniques. FA and PCA also involve the identification and assessment of the latent variables underlying a set of items. Readers are directed towards Tabachnick and Fidell (1996, 2001) for a detailed analysis of multivariate statistics.

An examination of previous questionnaire research into aspects of green supply chain management identifies the use of a range of statistical techniques in these studies.

- Descriptive statistics of means and percentage distributions: Baylis *et al.* (1998b), Bowen *et al* (2001a), Murphy *et al.* (1994), and Murphy *et al.* (1995).
- T-Tests: Autry *et al.* (2001), Murphy and Poist (2000), Schaper (2002).
- ANOVA: Bowen *et al.* (2001), Murphy *et al.* (1996), and Schaper (2002).
- Chi Squared: Prendergast and Pitt (1996).
- Analysis of Ranks: Min and Galle (1997).

- Correlation and Regressions: Carter *et al.* (2000), Carter *et al.* (1998), Theyel (2001), Klassen and Whybark (1999).
- Factor analysis: Bowen *et al.* (2001b), Carter *et al.* (1998), Carter and Carter (1998), Murphy *et al.* (1995), Zsidisin and Hendrick (1998).
- Hypothesis testing: Bowen *et al.* (2001b), Carter and Carter (1998), and Carter and Jennings (2002).
- Structural equation modelling (such as Amos): Rao (2002).

In addition to the prior research analysed by quantitative techniques, there are also a range of interview case study research that are influential in the discussion of findings of this thesis, namely Hall (2000: 2001), Gavaghan *et al.* (1998), Green *et al.* (1996), New *et al.* (2002), Rondinelli and Berry (1998) and Walton *et al.* (1998).

5.6 Issues of Comparability, Reliability and Data Quality

This next section examines the comparability of the respondents with the original sample, any potential non-response bias and the existence of any missing values[13].

5.6.1 Comparison of Respondents with Original Sample

In order to generalise the pressure/response model of green supply chain management it is important to examine whether the respondents are representative of the original sample. Table 5.5 examines the distribution of respondents in each sector compared with (i) each other and (ii) the original sectoral distribution of the 1457 organisations comprising the initial sample.

[13] Previously, general aspects of reliability and validity are discussed (section 5.3.1) and the specific response rates for this survey (section 5.4.2).

Table 5.5: Overview of the SIC distribution in original sample and the sectoral classification of survey respondents

Original SIC Classification in CIPS Database	Number in original sample	% of original sample	Classification used in survey	Number of Respondents	As % of respondents.	% respondents as from original sector group
Manufacturing	461	31.6	Manufacturing	44	29.5	9.5
Other	430	29.5	Other	31	20.8	7.2
National, Local Government & Education	267	18.3	Public	44	29.5	16.5
Wholesale & Retail	115	7.9	Retail/ wholesale	7	4.7	6
Construction & Mining/Quarrying	56	3.8	Construction	10	6.7	17.9
Transport and Storage	51	3.5	Transport & Logistics	3	2	5.9
Electricity, Gas and Water	46	3.2	Utilities	10	6.7	21.7
Agriculture, Forestry & Fishing	2	0.14	Agriculture	0	0	0
Detailed Breakdown of Other			*Other*			
Finance and Insurance	46	3.2	Mixture Service & Manufacturing	16	10.7	
Health & Social Work	70	4.8	Service	15	10.1	
Hotels & Restaurants	10	0.7				
Other Business Activities	150	10.3				
Post & Telecommunications	35	2.4				
Real Estate & Renting Equipment	5	0.3				
Research & Development	21	1.4				
Community, Social & Personal Service	27	1.9				
Computer & Related Activities	30	2.1				
Unknown	36	2.5				
Total (Other)	430	29.5	Total Other	31	20.8	7.2
Total	**1457**		**Total**	**149**		**10.2**

However, direct comparison between the original sample and the respondents is difficult, as there is not an exact match between the SIC class used on the CIPS database and the categories used in the research instrument. It was originally intended to use the SIC headings in table 5.5 as possible categories in the questionnaire and these were included in the original pilot study. However, the feedback from the focus and pilot stages suggested that using a long list of possible sectoral classifications, was too wordy and took up too much space in the questionnaire. Therefore, the decision was made to summarise the possible SIC headings into the sectoral classifications used in the final questionnaire.

Some trends do emerge from table 5.5. Two sectors (manufacturing and agriculture) show a similar percentage distribution of respondents compared to the percentage distribution of these groups in the original sample. The relative percentage composition of the public, utilities and construction sectors in the respondent sample are higher than in the original sample. Environmental issues are quite high profile in these three sectors and this might have led to an improved response rate. In addition, these three sectors tend to have higher external reporting requirements and may, therefore, be more used to returning information externally.

The difficulty in establishing a direct comparison between the original database sample and the respondents suggests that the respondents cannot be classed as definitively representative of the overall population of the CIPS. Since the CIPS database itself is not fully representative of whole of UK industry and the public sector, this lack of direct comparability would also exist even if the composition of the original database sample and the respondents were identical.

Yet, all survey research selects out a 'sample', be that a certain sector or size classification. So comparison of the composition of the respondents with the whole of the UK industrial base is an ambitious and perhaps unrealistic target. What is perhaps more important is that the respondents do represent a cross section of different industrial groupings from the CIPS database and by default UK organisations.

5.6.2 Non-response Bias

Carter *et al.* (1998) note that non-response bias is a potential limitation in survey research, even when there are relatively high numbers of return (i.e.

over 25%).

Non-response bias is briefly examined in section 5.4.2 where a number of approaches are recommended to address the bias that may result from non-respondents.

(1) Mail a slimmed down version of the questionnaire to non-respondents (e.g. Carter and Jennings 2004)

(2) Phone non-respondents and ask three questions from the original survey (e.g. Prendergast and Pitt 1996)

In both cases tests of difference can be used to see if there are statistically significant differences in the results between respondents and non-respondents.

When it is not possible to use the above approaches Armstrong and Overton (1977) and Lambert and Harrington (1990) suggest a simple test for non-response bias is to compare the responses of early and late respondents. The suggestion is that late respondents are more likely to response to survey questions in a similar manner to non-respondents. Therefore, if there are statistically significant differences between late and early respondents then non-response bias may be a factor within the study. Carter *et al.* (1998) conduct a multivariate T Test (the Hotelling-Lawley Trace) for key study variables between late and early respondents. In a similar manner, Autry *et al.* (2001) adopt the Armstrong and Overton (1977) guidelines for assessing non-response bias and compare their responses for the final quartile of respondents with the those responses from first three quarters of respondents.

The anonymous nature of the questionnaire and the UK Data Protection Act in place at the CIPS prevented a 'slimmed' down version of the questionnaire being mailed to non-respondents (as suggested by Prendergast and Pitt (1996) and Lambert *et al.* (1990)), nor could the researcher phone non-respondents. In this thesis questionnaires were returned to the CIPS before they were sent to the researcher. Therefore, this complicates the assessment of the chronological order in which they arrived as they were then forwarded in batches. However, once the researcher was sent each batch of questionnaires from the CIPS they were placed in order of their arrival. In a similar manner to the study by Autry *et al.* (2001), the final quartile of responses is compared using T-Tests with the first three-quarters of the sample of respondents order to assess non-response bias[14], as illustrated in table 5.6

Table 5.6: Tests of non-response bias (T-Tests) [15]

	Levene's Test for Equality of Variances			t-test for Equality of Means			Mean Diff.	Std. Error Diff	95% CI of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)			Lower	Upper
Legislation drivers	Equal variances assumed	0.42	0.52	0.21	144	*0.84*	0.04	0.19	-0.33	0.40
Supply chain	Equal variances assumed	0.40	0.53	0.67	141	*0.50*	0.13	0.20	-0.26	0.53
Societal drivers	Equal variances assumed	0.11	0.74	0.42	145	*0.67*	0.07	0.18	-0.27	0.42
Competitive	Equal variances not assumed	1.09	0.30	-0.76	56.04	*0.45*	-0.17	0.23	-0.63	0.28
Internal drivers	Equal variances assumed	0.00	0.97	1.24	144	*0.22*	0.23	0.19	-0.14	0.60
environmental attitude	Equal variances not assumed	2.94	0.09	-0.83	78.51	*0.41*	-2.39	2.88	-8.11	3.34
GSCM operational activity	Equal variances not assumed	8.96	0.00	0.20	91.69	*0.84*	0.58	2.88	-5.13	6.29
Supplier education coaching and mentoring %	Equal variances not assumed	2.00	0.16	0.56	70.64	*0.57*	2.61	4.63	-6.63	11.85
Green procurement and logistics policy	Equal variances not assumed	4.80	0.03	0.72	82.63	*0.47*	3.00	4.15	-5.25	11.26
Internal env. ops. management %	Equal variances not assumed	0.56	0.45	-0.35	58.18	*0.73*	-1.77	5.10	-11.97	8.43
Green logistics	Equal variances assumed	0.01	0.91	-0.10	139	*0.92*	-0.55	5.64	-11.70	10.61
Supplier assessment	Equal variances not assumed	7.73	0.01	0.95	77.59	*0.34*	4.81	5.05	-5.24	14.86
Industrial networks	Equal variances assumed	0.04	0.84	-0.59	138	*0.56*	-3.53	5.97	-15.32	8.27

14 Although some of the original constructs are not normally distributed the discussion presented in appendix 9 supports the use of parametric T-Tests (after De Vaus 2002).
15 Levene's Test for equality of variance suggests that if $p < 0.05$ then equal variances cannot be assumed.

Table 5.6 examines the results of T-Tests between early and late respondents for the scale variables transformed from the 'raw' items developed to measure the drivers of environmental management, environmental attitude and green supply chain management practices. None of these show significant differences between early and late respondents.

T-Tests between late and early respondents for the 103 original 'raw' variables (before transformation to the scales identified in table 5.6) identify only two with significant differences at the $p<0.05$ level, and neither of these are significant at the $p<0.01$ level[16].

- Pressure from employees (drivers of environmental management) $p = 0.04$
- No adverse knowledge of or see recent media coverage of poor environmental/ethical performance of supplier (criteria used to assess potential and current suppliers) $p = 0.03$.

Therefore, it could be assumed that non-response bias has not been found in the data in this thesis with reference to the guidelines established by Armstrong and Overton (1977), in the 103 'raw' variables or the new variable scales developed as part of the data transformation process (in chapters 7,8 and 9).

5.6.3 Missing Values

Examining all aspects of green supply chain management across the supply chain is fundamental in this study. However, this introduces a great deal of complexity into the questionnaire. The respondents were targeted during the database screening stage to identify upper levels of management and environmental personnel that would have a greater grasp of operational practices in the firm, but also knowledge of the factors in the external environment that were driving operational activity. The complexity of the questionnaire resulted in some organisations not answering all of the questions. On reflection, some questions were not suited to different types of

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16 The T-Tests for all 103 'raw' variables are not reported individually – only the ones those show statistically significant differences.

organisations, such as the item that asked if pressure from individual consumers was a significant external driver. For this item there were 66 responses, reflecting that the public sector and business to business firms on the whole did not answer this question as it did not seem 'appropriate' to them. If the respondent did not know the answer they appear to have not answered at all, as opposed to guessing, as evidenced by the mix of clear answers interspersed with missing values. This is a positive aspect of the targeting of the selected respondents, whom it might be argued are more used to answering questionnaires and therefore understand the implication of 'guessing' answers.

Therefore, the data transformation processes described in the upcoming chapters (for instance section 8.2) and in appendix 9 are designed to 'smooth' out the influence of missing values. The use of average scores for the driver scales produces a scale value for each case. In the development of the operational scales of green supply chain management practice the calculation of the 'score' by using only a confirmed action, as opposed to 'intend to' actions, results in a measure of 'activity' that reflects actual actions currently being undertaken. The presumption is that a missing value for these items suggests that the respondent did not know if these actions occurred. Since the research focus is on green supply chain management operational activities that are routinely taken, as opposed to ad hoc and one-off actions, a non-response for an operational activities suggest it is not routine. Due to the targeting of the questionnaire to senior level staff it could be presumed that if they did not know the answer then this type of operational activity is not embedded in the environmental strategy of the firm.

Therefore, the data transformation process used to test the green supply chain management pressure/response model minimizes the influence of missing values. However, values may also be missing for items that identify the organisational and demographic characteristics of the respondents. Again these missing values might be viewed as a positive aspect of the data collection process, indicating that when the respondents did not know the answer they left it blank. Some questions such as turnover and organisational structure (UK independent, Joint venture etc) had a large number of missing values. Therefore, these items can be used to describe the sample but have limited applicability in statistical analysis. Those items describing organisational and demographic characteristics with more than 5% missing values are not used for detailed statistical analysis (these are business type, business structure and turnover) but are used in descriptive evaluations in later chapters.

In the statistical tests of difference, such as Kruskal Wallis, cases with missing values are excluded from this analysis. Therefore, in the presentation of the statistical analysis in later chapters the frequency (n) value is identified to indicate the total number of cases examined. When necessary the *'valid percentage'* values are indicated, representing the percentage of the total number of cases used excluding any missing values.

5.6.4 Limitations to Research Methodology

Section 5.6.1 identifies the sectoral distribution of the respondents in comparison with the original sample. The findings suggest that the ranked distribution of the original sample and the respondents is similar, with the largest number of responses coming from manufacturing and the public sector. However, except for manufacturing, the percentage composition of the original dataset and the respondents is not identical. Some sectors such as public, utilities and construction had response rates from 16.5% to 21.7% whereas, transport/logistics and retail/wholesale had response rates of 5.9 % and 6.1% respectively. Thus, the average 10.2% response rate is not mirrored in each sectoral group (except for manufacturing) and this is a potential limitation of the research.

The respondents in this questionnaire are also biased towards larger organisations, in common with many previous similar studies (Carter and Carter 1998; Carter *et al.* 1998 2000; Min and Galle 1997; Murphy *et al.* 1994, 1995, 1996). Since micro and small businesses constitute the majority of registered companies in the UK, the lack of focus on these in this work is a limitation to the methodological approach. However, the difficulty of reaching this audience, and lack of membership in the CIPS by SME staff, prevented the inclusion of this group in the survey. The exclusion of all companies of less than 10 employees is an attempt to reduce the distorting influence of micro businesses, but small and medium firms were still included to see if size is a significant influence upon green supply chain management.

An examination of non-response bias (section 5.6.2) suggests that it is not significant based upon the Armstrong and Overton (1977) guidelines. However, the inability to contact respondents and follow up the first distribution of the questionnaire with telephone enquiries to improve response rates does weaken the assessment of non-response bias and this is another potential limitation of the approach taken in this thesis.

Another limitation to the approach taken in this thesis, is the lack of structured framework on green supply chain management, which meant that data constructs were 'collected' from a range of prior publications. Many of these publications examine different sectors, sizes, geographical locations and most importantly different aspects of green supply chain management. Therefore the items used in the questionnaire came from very different sources and some of these items are empirically validated and others are anecdotal or conceptual.

This section identifies four potential limitations to the research study:

- Differing response rates in different sectors;
- Bias towards larger organisations;
- Difficulties in testing for non-response bias; and
- Use of a variety of previous studies to identify a range of constructs in the research instrument.

However, the approach taken in this thesis aims to minimise the influence of these. Investigation of the influence of organisational contingencies (i.e. the demographic characteristics of the sample) allows a clearer examination of the influence of sector and size, and reinforces the need to adopt a cross-sectoral approach. Whilst non-response bias cannot be explored by the mechanisms suggested by Carter and Jennings (2004) and Prendergast and Pitt (1996), testing late and early respondents as suggested by Armstrong and Overton (1977) and Lambert and Harrington (1990), is a valid approach and used in other similar studies. The use of constructs from a range of previous research studies is a form of triangulation and is suitable for a theoretically emerging field.

5.7 Overview of the statistical analysis presented in this study

In the next remaining chapters the findings from the survey research instrument are examined in light of the green supply chain management pressure/response model presented in chapter three and the literature review (chapter 2). For ease of dissemination the statistical analysis of the findings are presented as follows

Chapter 6 examines the descriptive demographic characteristics of the 149 respondents to the survey. In later analysis, Kruskal Wallis non-parametric tests examine the a range of dependent variables in each aspect of the pressure/response model by clustering respondents into demographic groups to see if these characteristics modify elements of the model (for example section 8.3.2). If differences are apparent between groups then this suggests these demographic characteristics may be influential predictors of behaviour.

Chapters 7-9 examine and explore the three elements of the pressure/response model of green supply chain management. The first aspect of the model examined is the external drivers of environmental management, comprising of legislative, supply chain, competitive and societal factors (chapter 7). This chapter also presents the new numerical scale variables created through a principal component analysis and average scores, which encapsulate the original constructs used to measure the external drivers. Chapter 8 examines the second aspect of the pressure/response model focussing on internal factors affecting green supply (comprising of internal drivers, a measurement of environmental attitude and internal obstacles). The third section of the model is explored in chapter 9, focussing on the green supply chain management operational practices of the respondents. Chapter 10 examines the specific relationships between these three elements of the model, using correlation and regression models.

In each chapter, findings from previous research studies are referred to in light of the results presented. None of the previous studies examine green supply chain management across the whole of the supply chain, or with such complexity, as the study presented here. Therefore, it is important to mention similar and contradictory results in the different elements of the model as these findings are examined (chapters 7-9). These findings are brought together to present a discussion of the model developed in chapter 3, explored in chapters 7-9 and tested in chapter 10.

CHAPTER 6: SURVEY RESPONDENTS AND DEMOGRAPHIC CHARACTERISTICS

6.1 Introduction

In the first chapter (section 1.4) it was established that this study develops and tests a generic pressure/ response model of green supply chain management, and examines how this model is moderated by organisational contingencies. These contingencies are examined though the demographic characteristics of the respondents, related to aspects such as the size of the organisation and sector. A critique of the possible influence of demographic characteristics upon green supply chain management is presented in section 1.3.4 in the literature review and discussed in section 3.3.4. Before the analysis of the green supply chain model is presented in later chapters it is necessary to present a descriptive overview of the demographic characteristics of the respondents, and establish which of these demographic characteristics will be used in this later statistical analysis.

Some statistical techniques used in this study require a minimum number of values in each cell to be valid (see appendix 9). Where appropriate, the data on organisational contingencies is 'collapsed' into a smaller number of categories in order to improve the statistical analysis in later chapters. This process of grouping cases into smaller numbers of valid categories is recommended by authors such as Bryman and Cramer 2001; De Vaus 2002; and Tabachnick and Fidėll 2001.

This chapter examines five groups of organisational contingencies. Firstly, sector is examined (section 6.3), then the size of the organisation (section 6.4), level of potential environmental risk / impact (section 6.5), dependency on customers and suppliers (section 6.6), and the influence of nationality (section 6.7).

6.2 Description of Respondents

This section examines the roles that the respondents have in the organisation. As discussed in section 5.2.2 it is important that the respondents come from functional areas that allow them to comment on a wide range of policy and management practices (Reynolds *et al.* 1993), and are involved in a managerial and decision making role. Respondents who are sufficiently embedded in the management 'hierarchy' would arguably be more aware of cross-functional environmental initiatives.

Table 6.1: Roles and responsibilities of respondents from each organisation

Roles in Organisations	Number *
Purchasing	139
Managerial decisions	65
Middle management	56
Implementing environmental policies	48
Logistics	44
Top management	34
Part of an environmental division or have specific environmental responsibilities	18

* Multiple responses from respondents

The majority of respondents (93%) have purchasing roles. Table 6.1 illustrates that most, if not all respondents, identified more than one role for themselves in the organisation, which suggests that the wide spread of their responsibilities would allow respondents to have a good working knowledge of all the areas discussed in the green supply chain management pressure/ response model developed in chapter 3.

6.3 Sector

In this study one of the critical arguments expressed in chapter one is the need to develop a generic model of green supply chain management based on a cross-sectoral sample. However, the level of external and internal pressure to adopt green supply chain management practices may differ between different sectors, and potentially moderate the relationships in this generic model. In fact, exploratory and theory building studies on aspects of green supply chain management (such as Carter and Carter (1998), Murphy *et al.* (1994) and Min and Galle (1997)) use targeted industrial groups, especially specific 'dirtier' industries, to explore specific aspects of green supply chain management which suggests that sector may actually influence management practices. However, the focus in this study is on the development and testing of a model that may apply to a range of industries and how this model may be moderated by organisational contingencies[1].

The distribution of organisations within the sample consists of public sector organisations (29.5%) and manufacturing (29.5%), with a further 10.1% from service organisations. A further 10.7% identify themselves as a mixture of service and manufacturing. The remainder of the sample consists of a range of organisations: construction (6.7%), utilities (6.7%), retail (4.7%), and transport and logistics (2%).

Chi-squared and other statistical tests require a minimum of five values in each category (see appendix 9). Therefore, the small number of respondents in some of these sectoral groups suggests the need to collapse some of these categories into larger sized groupings that are more suitable for statistical analysis. The construction, utilities and transport sectors are all fairly high profile in terms of environmental issues and are therefore grouped together. Whereas retail/wholesale and service sectors have arguably lower levels of environmental impact and tends to experience less overt environmental pressure, and so are grouped together. The remaining categories remain in their original group. In the later statistical analysis (chapter seven onwards) the sectoral classifications are clustered into:

- Public (29.5%)
- Construction, utilities and transport/logistics (13.6%)
- Retail/wholesale or service (14.8%)
- Manufacturing (29.5%)
- Mixed manufacturing and service (10.7%).

1 Section 1.3.4 presents a detailed analysis of the benefits from adopting a cross-sectoral approach in this study.

6.4 Size of the Organisation

The Department of Trade and Industry (DTI) company size definitions are adopted in this study, where small firms have less than 50 employees, medium have 50-249 employees and large have 250 or more. Micro firms are normally counted as 'small' firms but typically have 1-9 employees. Size might be a critical factor influencing the success of green supply chain management. SMEs typically struggle with integrating environmental issues into management operations as they lack resources and manpower to deal with environmental initiatives (Holt *et al.* 2000; Baylis *et al.* 1998a,1998b,1998c; Hillary 2000). Yet, SMEs are under pressure through the supply chain to adopt environmental practices, with organisations such as Nortel identifying the inability of SMEs to meet the environmental demands of larger companies (BiE 1997).

There is now a growing body of literature on sustainable business practices (such as Welford and Gouldson 1993; Welford 1995; Lober 1996; Hutchinson and Hutchinson 1997 and presented in summative form in appendix 2). However, much of this literature and environmental management tools and techniques originate from case studies in large organisations (as discussed by Elliot *et al.* 1996). Therefore, size may be an important variable in this study.

Yet, similar studies in the US that selected members of a professional body as the research sample to investigate aspects of green supply chain management, found the membership of these bodies dominated by larger organisations (Carter and Carter 1998; Min and Galle 1997; Murphy *et al.* 1994, 1995, 1996). Members from larger organisations likewise dominate the CIPS database used in this study. This is mainly because larger organisations are more likely to have function specific staff in purchasing and logistics departments, who would then join a specific type of professional body such as NAPM in the USA or the CIPS in the UK. This potential bias within the CIPS database is discussed in section 5.6.4.

Since the CIPS database is biased towards larger organisations the original database sort was designed to exclude when possible micro businesses of less than 10 employees. The small and medium organisations were grouped together into the SME category, in line with other research studies that examine the impact of size on environmental processes (such as Autry *et al.* 2001; Baylis *et al.* 1998a, 1998b). As illustrated in table 6.2 only 5.4% of the sample is classed as 'small' and 24.4% classed as 'medium' and 69.8% as large

Table 6.2: Size Classifications of Respondents

No. Employees	Frequency	%	Dti Classification		Size Classification used in analysis	
1-9	4	2.68	small	5.37	small/medium < 250	30.2
10-49	4	2.68				
50-99	13	8.72	medium	24.83	Large 250-999	20.13
100-249	24	16.11				
250-499	19	12.75	large	69.80	very large 1000+	49.66
500-999	11	7.38				
1000+	74	49.66				
Total	149					

Due to the small number of responses in some of the size grouping in table 6.1, a size classification (adapted from the DTi classification scheme) of medium/small (<250), large (250-999), very large (1000+) is used in the later statistical analysis. Given that the sample is biased towards larger organisations the category 'very large' is added to reflect the diversity of responses from these larger sized organisations.

6.5 Possible environmental risk and impact

The level of environmental impact and environmental risk of each organisation might be a more useful classification for predicting environmental activity than sector or size as these measures cross 'rigid' size and sector classifications. Command and control environmental legislation (after Bell 1997) targets specific high risk/impact processes and products, rather than company size or broad sector. The level of possible environmental risk and environmental impact of the organisation are 'self-perception' measures by each organisation. It could be argued that it is the perception of external and internal pressures by an organisation that governs organisational behaviour. The dirtier, higher risk industries such as the chemical sector appear to be more active in environmental management activities as discussed by Welford (1999) and Frankel (1998). However, green pressure group lobbying/ or criticism on a specific issue of a retail or light manufacturing company, might lead to a perception by that organisation of a high level of environmental risk and subsequently influence behaviour – even though their processes are less 'damaging' than for instance a chemical company. Therefore, this measure allows the perception of potential environmental risk and impact to be included as a relative perceptional measure by each organisation (table 6.3).

Table 6.3: Perceived levels of environmental risk and impact

Level of Potential Environmental Risk and Impact	*Classification scheme in original question*					*Classification used in analysis*	
	negligible	low	medium	high	Total	Lower	Higher
Environmental Risk	32	57	37	21	147	89	58
%	21.5	38.3	24.8	14.1		59.7	38.9
Environmental Impact	24	56	44	24	148	80	68
%	16.1	37.6	29.5	16.1		53.7	45.6

If this study was based in the US, data such as the Toxic Release Inventory Red List held by the USA Environmental Protection Agency could be used to triangulate this data and examine these perceptional values relative to each organisation. Such information could be used as surrogate measure of impact and risk in a way that is identical for every organisation. In the UK there are no similar publicly reported statistics available for all types of organisations in the sample and would also be unavailable for the anonymous respondents in this study.

These designations of environmental risk/ impact are self-selected, with each respondent making a decision based upon their own interpretation of whether they are negligible, low, moderate or high level. In order to counterbalance this, and facilitate the use of advanced statistical techniques (like multiple regression), the organisations are grouped into two categories of lower (incorporating negligible and low) or higher (incorporating moderate and high) environmental risk and impact.

Table 6.3 suggests that the slightly more organisations are classed as *higher* environmental impact (45.6%), than those classed as *higher* environmental risk (38.9%). This may be related to the public relations and liability concerns associated with publicly declaring an organisation as 'high' environmental risk. The use of the two classifications of 'lower' and 'higher' in the statistical analysis is designed to minimise this effect, by grouping medium and high into one category, as the presumption is that high risk/impact organisations would answer 'medium' risk when refusing to publicly categorise themselves as high risk.

6.6 Dependency on Customers and Suppliers

This section focuses on the dependency of the respondents upon their suppliers and their customers. Hall (2000) discusses the concept of channel power, whereby the most powerful member of a supply chain may control or influence the processes and decisions made in that supply chain. It could be argued that if an organisation is overly dependent on a particular supplier or customer then they are no longer the most 'powerful' organisations in that particular supply chain. To examine role of dependency on customers and suppliers it is important to establish the number of customers and suppliers in each organisations, how close the organisation is to the general public, and to what extent the respondent organisations are critically dependent upon a particular supplier or customer

6.6.1 Numbers of Customers and Suppliers

All of the respondents have a minimum of ten suppliers and over 20% of respondents have more than 5000 suppliers (figure 6.1). The number of customers an organisation is very diverse with almost 5% of the respondents having a maximum of four customers, which might suggests that these organisations are potentially heavily dependent upon retaining the business of these specific customers. The more customers an organisation has, the less dependent it might potentially be on any one customer who chooses to impose environmental standards. In comparison, 16% of the respondents have over 5000 customers (figure 6.1). Only 28% of the respondents supply goods and services to individual members of the general public as well as other organisations, suggesting that the corporate customer may be potentially more influential than the individual consumer (Green *et al.* 1996).

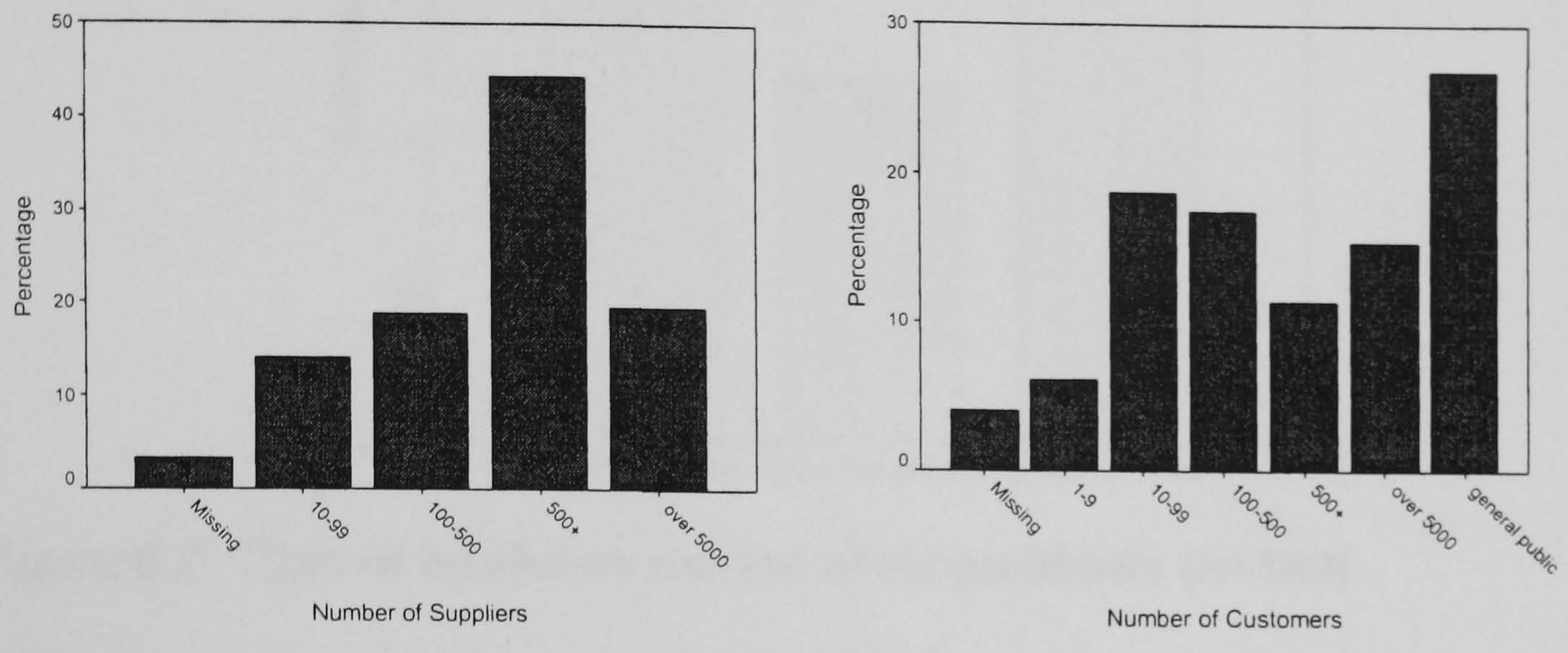

Figure 6.1: Number of suppliers and customers and amongst survey respondents

6.6.2 Market Structure

An examination of the market structure of each organisation provides an overview of the 'type' of customers these organisations may have. A business-to-business (B2B) market may present organisations with different levels of pressure through the supply chain, than a purely business-to consumer (B2C) who might experience higher levels of pressure from societal drivers. As illustrated in figure 6.2, 42% of respondents are involved in B2B transactions, 34% provide goods and services to individual consumers or the general public and 24% are classed as mixed B2B and B2C. However, only six organisations state that they are involved in purely business to consumer transactions, suggesting that inter-corporate trade and the public services dominates the sample. Green *et al.* (1996) notes that volume of inter-corporate trade is much greater than that of consumer trade, and therefore other organisations, rather than the individual consumer, might drive green supply chain management initiatives[2]. In this study lack of suitable data on turnover does not allow a realistic assessment of whether the *value* of consumer activity is greater than that of purely inter-corporate trade.

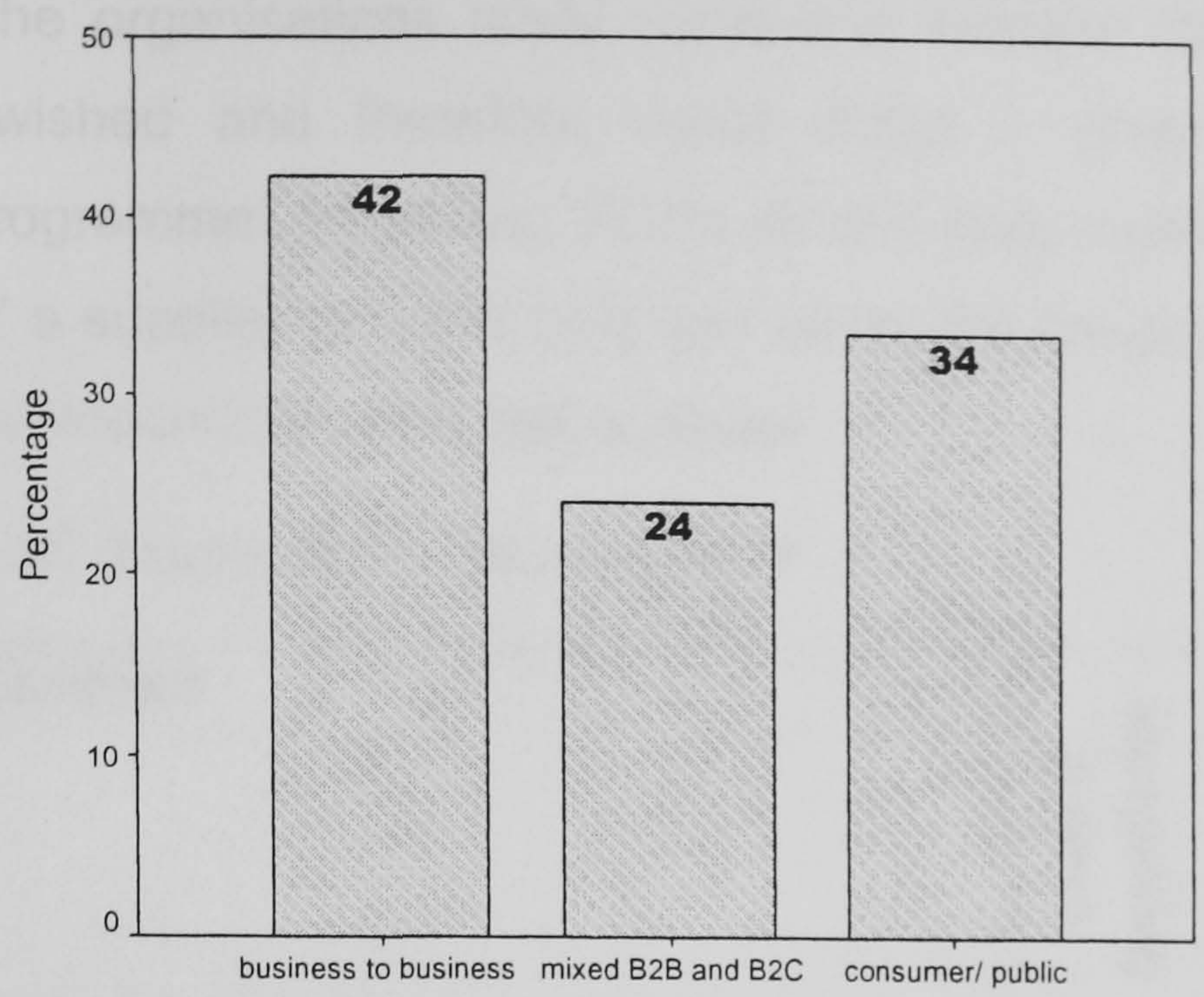

Figure 6.2: Type of business market of respondents (n=149)

An examination of the influence of market type may suggest that different levels of environmental pressure and operational activity occur in those groups that only 'sell' to one of these groups. None of the previous green supply chain management research studies examined in table 1.1, specifically examine the influence of market type. A comparison of the findings between the B2B and B2C group might suggest if pressure in the supply chain is coming from individual consumers or industrial customers.

6.6.3 Level of Control Organisation has over Decision Making - Critical Dependency on Customers and Suppliers

As discussed previously in this section, the idea of 'channel power' may be influential in the study of green supply chain model and in the

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2 A discussion is presented in section 2.2.2 on the difference between individual 'environmental' values and those reflected by the environmental culture of the organisation. If an organisation is closer to the general public or individual end consumer it might be presumed that the personal values of an individual have more influence on purchasing decisions. However, the role of 'green champions' in organisations may reflect their own individual personal values.

pressure/response model developed in chapter 3. As illustrated in table 6.4, 74.2% of the respondents have either multiple sources of suppliers or are able to approach other suppliers for critical goods and services. This data suggests that 74.2% of the organisations could remove a supplier from their supply chain if they wished and therefore could adopt a green supply chain management programme. However, 25.7% of the respondents would find it difficult to 'force' a supplier to make changes using the threat of deselection if they are critically dependent upon that supplier.

Table 6.4: Critical dependency on suppliers

Dependency on Suppliers	Level of Dependency	Frequency	Valid Percentage
We have a few key suppliers upon which we are critically dependent	High	36	25.7
We have a few critical suppliers but can approach others if necessary	Moderate	52	37.1
We have multiple sources of suppliers we can approach	Low	52	37.1
Missing responses		9	

Approximately 46% of the organisations (n=60) who responded state that their customers have little control over their organisation's decision making (table 6.5).

Table 6.5 : Critical dependency on customers

Dependency on Customers	Level of Dependency	Frequency	Valid Percentage
Our customers have little influence over our decision	Low	60	46.2
More dependent on some customers than others. If asked to make changes by major customer would do so	Moderate	53	40.8
We have no choice but to adopt whatever environmental criteria we are required to	High	17	13.1
Missing		19	

Yet, 13.1% of respondents would have no choice but to make whatever environmental improvements a customer requested. A further 40.8% state it would depend upon which customer was demanding changes. Therefore, table 6.5 suggests that a significant number of the organisations in the sample (70 in total) are affected by customer dependency to a moderate or high extent.

Rather than use the actual number of suppliers and customers in later statistical analysis, the two variables in table 6.4 and 6.5 are used to test the influence of *critical dependency on customers and suppliers*. The reason for this decision is that actual number of suppliers and customers is not necessarily indicative of their critical nature. For instance an organisation may have thousands of suppliers but remain dependent on a small number who provide components unavailable elsewhere. Correspondingly an organisation with a hundred customers may provide virtually all its business to only one of these customers.

If the dependency on suppliers is cross tabulated against dependency upon customers the findings become even more interesting (table 6.6)[3].

Table 6.6: Comparison of dependency on customers and suppliers

customer dependency		**supplier dependency**				Total
		low	moderate	high	Missing	
low	Count	28	28	12	3	71
	%	39.4	39.4	16.9	4.2	100.0
moderate	Count	13	17	19	4	53
	%	24.5	32.1	35.8	7.5	100.0
high	Count	**7**	**4**	**4**	**2**	**17**
	%	41.2	23.5	23.5	11.8	100.0
Missing	Count	4	3	1		8
	%	50.0	37.5	12.5		100.0
Total	Count	52	52	36	9	149
	%	34.9	34.9	24.2	6.0	100.0

A scenario potentially exists where an organisation that is critically dependent upon a small number of suppliers may also be dependent for sales upon a

3 Missing responses from public sector organisations in table 6.5 were recoded as 'low;' for table 6.6 based on an examination of the responses from other public sector organisations in the sample (such as the NHS and local authorities).

single customer. If this customer requests changes in product design from the supplier organisation they may have no choice but to acquiesce, but may be constrained by the refusal of their own supplier(s) to adopt new practices or specifications.

Table 6.6 suggests that a possible conflict exists between organisations that have no choice but responding to customer requests, yet are also dependent upon a few critical suppliers. If this organisation is less powerful than their supplier they might be unable to force the supplier's compliance, thus failing to meet their own customer's imposed environmental requirements. Four of the respondents that are highly dependent on customers are also highly dependent on key suppliers. A total of seventeen organisations are highly dependent on their customers and might have to adopt what ever green supply chain practices required by these customers.

This suggests that the critical dependency of the organisation on suppliers and customers may be influential factors affecting the success of any green supply chain management programme. However, a contingency co-efficient test for the data in table 6.6 is not significant, and fails to finds a significant difference between the groups (p=0.280)[4], and therefore does not statistically support the assumption than high supplier and customer dependency alters the 'balance of power' in the supply chain. However, the small sample size suggests that this statistical 'proof' needs further investigation in a larger sample.

6.7 Nationality

Whether an organisation follows the environmental standards set in the UK, or by an overseas parent organisation, may lead to differences in the type and

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[4] The large number of missing responses does weaken this test. It should be noted that none of the respondents refused to answer both questions, suggesting that when confident the respondents answered. This is a positive point to note with regard to missing values as respondents appear to have chosen not to respond rather than 'guess', reflecting the careful targeting of respondents as part of the data collection phase discussed in chapter 5.

level of green supply chain management practices. For instance, Carter *et al.* (1998) found that German firms were significantly more involved in environmental purchasing than US firms. Their study also identified the need to compare environmental purchasing activities between national cultures. To investigate the possibility that national 'culture' affects green supply chain management, a measure was developed to identify each respondent as *'UK controlled'* or *'non-UK controlled'*. This measure was developed using two constructs from the questionnaire[5]. These constructs were used to validate each other, allowing any missing answers to be interpreted.

For instance, there were fourteen missing answers to the question on organisational structure (table 6.7). Nine of these were UK public sector organisations, two were single UK independent companies and one a UK based group. Therefore these twelve organisations were classed as UK controlled. One company classed itself as an overseas group, with a Danish parent company and was classed as non-UK controlled.

Table 6.7: Organisational structure of respondents

UK Controlled	**Frequency**	**%**
Main UK HQ with subsidiary sites controlled by HQ	62	41.6
Devolved UK site with independent authority	34	22.8
Single UK site	23	15.4
Non UK Controlled		
Franchise organisation (overseas group)	1	0.7
Overseas HQ with UK site(s) controlled by HQ	15	10.1
Missing	14	9.4

The second *UK-controlled* construct question examined the nationality of the respondent's parent company. The fifteen companies in table 6.7 that classed themselves as a UK site controlled by an overseas parent group identified the nationality of the parent group as USA (5)[6], Germany (3), Ireland (1), Japan (1), Swedish (1), Switzerland (2), Denmark (1), France (1) and Canadian (1).

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[5] Q4 & Q6 in final questionnaire related to type and structure of organisation
[6] (number of responses)

The number of responses from each of these national 'cultures' is too small to make a definitive assessment of the influence of each. Therefore, a single composite measure of 'non-UK controlled' is used to assess these (as illustrated in table 6.8).

Table 6.8: Distribution of UK controlled and non-UK controlled respondents

	Number of Responses	Percentage
UK controlled	132	88.6
non UK controlled	16	10.7
Total	148	99.3
Missing	1	0.7

Only 10.7% of the respondents were 'controlled' by an overseas parent company or franchise agreement. The remaining 88.6% of the respondents was under the direction of an UK based head office, devolved site or single UK based site[7].

Since the non-UK controlled measure is from a sample with multiple national cultures, the difficulty of using this measure is that each of the countries may have different environmental standards. For instance, Germany is identified as having one of the most progressive national environmental cultures, with Barry *et al.* (1993) and Carter *et al.* (1998) finding significant differences between German and US firms in terms of green purchasing. To explore the influence of any national environmental culture, Mann-Whitney U non-parametric tests on each of the elements in the green supply chain management pressure/response model between the UK controlled and non-UK controlled groups were conducted (table 6.9).

[7] Level of control assessed by using responses from two questions relating to organisational structure (UK group, overseas group etc) and level of controlled (Independent UK site, Overseas HQ devolved UK site, overseas HQ subsidiary UK site etc.)

Table 6.9: Significant differences between UK controlled and non-UK controlled respondents

Test Statistics	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Average score for supply chain	592.5	8593.5	-2.7	**0.01**
Average score for legislation drivers	858	9243	-1.1	0.27
Average score for societal drivers	447.5	4818.5	-1.9	0.06
Average score for competitive	684	8434	-2.0	**0.04**
Average score internal drivers	688.5	8563.5	-2.0	**0.04**
Percentage score for environmental attitude	700.5	9478.5	-2.2	**0.03**
Average score Internal Obstacles	840	976	-1.1	0.28
Average score Supplier Obstacles	897.5	1033.5	-0.7	0.47
GSCM operational activity – percentage	778.5	9556.5	-1.7	0.09

Significant differences between the UK controlled and non-UK controlled groups should be viewed with caution because of the mix of nationalities reflected in the non-UK group. However, the mean rank scores for the significant differences identified in this table are higher for the non-UK sample for each of the four driver variables (supply chain, competitive, internal and environmental attitude). Yet, the operational variable (green supply chain management operational activity) is not significantly different between the two groups. This suggests that the non-UK group experiences greater pressure from the external and internal drivers, and have a more positive environmental attitude, but this pressure is not translated into significantly different levels of green supply chain management practices. A much larger sample is needed to examine specific influences of named countries, such as Germany or the US, and this is a possible avenue for future research.

Given the caution expressed above with regards to using national 'culture' as a predictor of behaviour this specific organisational contingency is not used in later statistical analysis.

6.8 Summary of Demographic Characteristics used in Later Statistical Analysis

Table 6.10 summarises the different organisational contingencies of the respondents selected for use in the statistical analysis presented in later chapters. This indicates what the constituent values are for each of these independent variables, reflecting where data transformations have taken place to make the values more suitable for statistical analysis.

Table 6.10: Summary of the organisational characteristics used as independent variables in later statistical analysis.

Organisational Contingency/ Demographic Characteristic	Values	Type of Variable
Sector All sectors	Public Construction, utilities/ transport/ logistics Retail/ wholesale / service Manufacturing Mixed manufacturing and service	Categorical 3+ groups
Market Structure/ Type of Customer	Business to Business Business to Consumer Mixed B2B and B2C	Categorical 3+ groups
Size classification	medium/small (<250), large (250-999), very large (1000)+	Ordinal 3 + groups
Dependency on Suppliers	Low, moderate, high	Ordinal 3 + groups
Dependency on customers	Low, moderate, high	Ordinal 3 + groups
Possible Environmental Risk	Lower, higher	Dichotomous
Possible Environmental Risk	Lower, higher	Dichotomous

The green supply chain model developed and tested in this thesis might be moderated by the organisational contingencies detailed in table 6.10. Section 1.4 (objectives 3.2 and 3.3) discusses the research aims in this study associated with the influence of these organisational contingencies. The statistical analysis of their influence is presented in chapters 7, 8, 9 and 10[8].

6.9 Conclusions

In conclusion there are two key points that are raised by the exploration of the organisational contingencies/ demographic characteristics of the respondents in this study:

- The respondents are not a homogeneous group, representing a range of sectors and company sizes. The approach taken in this study is a cross-sectoral one, and aims to test a generalised model of green supply chain management. Therefore, this chapter confirms that the model is tested on a mixed group of organisations; and

- There is a variety in the type and level of external and internal pressures, and green supply chain management practices that can be investigated by examining different organisational groups, clustered according to their organisational contingencies.

There are seven organisational contingencies used in the later statistical analysis. These are sector, size, type of customer, critical dependency on suppliers / customers, and levels of potential environmental risk / impact of the organisations in the sample.

This study now presents the statistical exploration of the three component elements of the pressure/response model of green supply chain management developed in chapter 3. These three elements comprise of the external drivers (chapter 7), the internal factors (chapter 8) and green supply chain management operational activities (chapter 9). The relationships between these three elements are statistically tested in chapter 10, incorporating the moderating effect of these different organisational contingencies.

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[8] section 7.5, 8.3.2, 8.4.2, 8.5.2, 9.4, 9.43, 10.5

CHAPTER 7: EXTERNAL DRIVERS OF ENVIRONMENTAL MANAGEMENT.

7.1 Introduction

The green supply chain pressure response model developed in chapter three comprises of three elements (external drivers, internal factors and operational responses). It is the first of these elements, the external drivers, that is examined in this chapter.

This chapter:

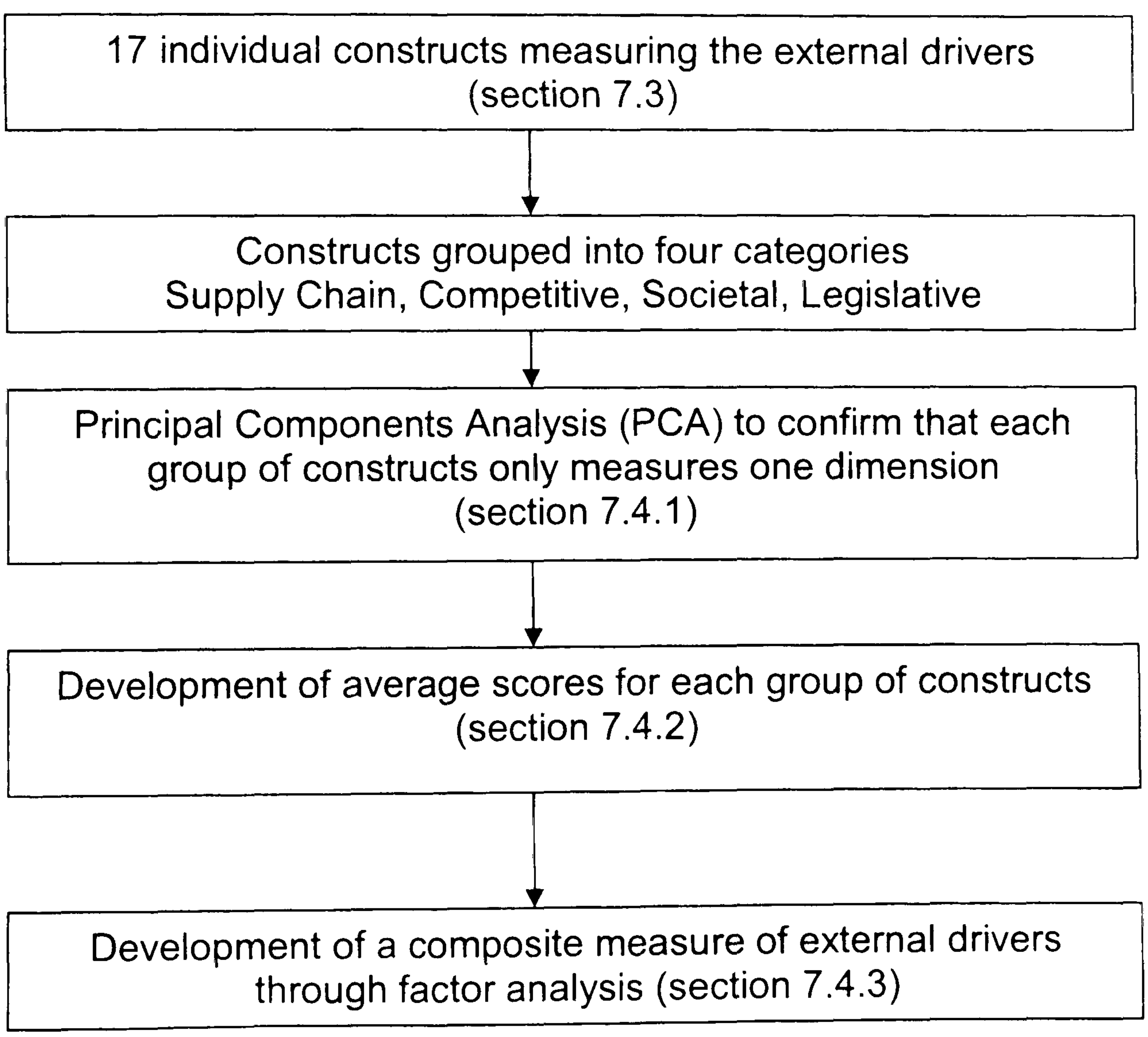
- Provides a general summary of the data transformation process of the external drivers (section 7.2);
- Presents a descriptive overview of the individual constructs measuring the external drivers constructs (section 7.3) ;
- Develops new scale variables to measure the external drivers (section 7.4);
- Examines whether the external drivers variables are moderated by the organisational contingencies of the respondents (section 7.5); and
- Summarises the moderating effect of these contingencies upon the variables measuring the external drivers (section 7.6).

The previous chapter introduced the organisational contingencies (such as sector, size) of the respondents, with the suggestion that they may moderate the relationships in the generic green supply chain model developed in chapter 3. This chapter examines their effect on the individual variables measuring the first part of this model, the external drivers, as a precursor to the testing of this model in chapter 10. The 17 external constructs are first examined individually, before transformation into numerical scale variables suitable for later statistical analysis. Then the external drivers are examined in relation to the organisational contingencies in chapter 6. The remaining two chapters (7 and 8) each examine the other two aspects of the green supply chain pressure response model (the internal drivers and operational activity) and follow the structure outlined in this chapter.

7.2 Data Transformation Process

This section introduces the transformation of the constructs developed to measure the external drivers into scale variables, to reduce the data to summative scales and facilitate detailed statistical analysis. This data transformation process is detailed in figure 7.1. At each transformation stage the findings are examined and discussed.

Figure 7.1: Summary of the data transformation process for external drivers



Three forms of data transformation are undertaken to reduce the seventeen constructs measuring the external driver to more manageable scale variables. Firstly, a principal components analysis (PCA) is performed for each group of constructs measuring each type of driver (for example the four constructs measuring legislation). This helps to establish how many dimensions these constructs measure. If only one component is extracted this suggests that there is only one dimension captured by each group of constructs and that it is viable to combine them (after Blaikie 2002; Tabachnick and Fidell 2001). Secondly, to compensate for any missing values average scores can be calculated for each dimension. Missing values affect statistical tests that are used in this study, where missing values lead to the removal of a case for a particular analysis, further reducing the sample size the statistical 'proof' is based upon (discussed in detail section 5.6.3).

These first two stages result in two types of variables (1) PCA for competitive, societal, supply chain and legislative drivers (2) average scores for competitive, societal, supply chain and legislative drivers. To confirm the accuracy of the average scores for each group of the external drivers they can be correlated with the PCA scale developed previously. If the PCA scale and the average scores are highly correlated then either scale can be used in later analysis (after Blaikie 2003). The average scores are preferable to the PCA values as the score for each case can be compared with the original Likert scale used in the questionnaire[1].

In the final stage of the data transformation, a summative measure of the totality of external drivers is developed. If any of the external driver scale variables are highly intercorrelated this can affect later statistical analysis (as discussed in section 10.2). De Vaus (2002:350) suggests that intercorrelated variables should be combined into a single measure using a PCA and the resultant component scores used in statistical analysis. Therefore, a PCA on the four constituent average score scale variables developed in section 7.4.2 produces a single summative measure of the external drivers (section 7.4.3)

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1 The average score is calculated by summing the Likert scale for each group of constructs and dividing by the total number of actual responses on a case by case basis.

7.3 Descriptive Overview of the Influence of External Drivers

This section presents an initial evaluation of the individual constructs measuring the external drivers in the green supply model. Table 7.1 presents the arithmetic mean score and rank order for each of the seventeen constructs measuring the perceived influence of external drivers for the 149 respondents[2] [3]. The arithmetic mean and rank position of each of the driver constructs is used rather than their percentage distribution in order to assess their relative position when compared with each other.

As illustrated in table 7.1, the most influential external drivers of environmental behaviour in the respondent organisations are *legislation* (constructs ranked 1st, 2nd & 5th), *image* (ranked 3rd) and *managing actual and perceived risk* (4th & 6th). The least influential are *pressure exerted by the insurance industry* (ranked 18th), *shareholders* (19th), *employees* (21st) and *green pressure groups* (22nd). The *influence of an organisation's suppliers* is low (ranked 20th) compared with *influence of their customers* (ranked 13th). The minimum mean score in table 7.1 is 2.4 for *pressure from green pressure groups*. This mean reflects the original Likert scale used in the questionnaire where 2 represents '*to a small extent*' and 3 '*to moderate extent'*. Thus, a mean value of 2.4 for the least influential driver in table 7.1 suggests that **all** the drivers in the table have at the very least a small influence on the behaviour of the organisations that responded.

The results presented in table 7.1 show some similarity to many of the previous studies that examined the influential drivers of environmental behaviour. A preliminary examination of some of these is presented in the next section.

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2 Internal drivers are not discussed in detail in this chapter but are presented in table 7.1 for the purpose of comparison.

3 The number of responses in table 7.1 for each construct varies due to some missing values which are addressed through the data transformation into average scores to reduce the influence of these as discussed in section 5.6.3

Table 7.1: The factors influencing the drivers of green supply chain management

1= negligible, 2 = small extent, 3 = moderate extent, 4 = great extent, 5 = very great extent Constructs measuring the External and Internal Drivers	Number Responses	Mean	Std. Deviation	Rank Order
Legislation				
Influence of UK's current environmental legislation	146	4.2	1.0	1
EU's current environmental legislation	146	3.9	1.2	2
Forthcoming environmental legislation	143	3.6	1.1	5
Possible environmental legislation in the future	145	3.3	1.2	10
Supply Chain				
Requirements of organisations that you supply to	132	3.3	1.4	11
Encouragement from organisations that you supply goods and services to	133	3.0	1.2	13
Pressure from individual consumers/ service users [4]	66	2.8	1.3	17
Influence of your own suppliers that provide goods and services to your organisation	142	2.7	1.1	20
Societal				
Public opinion/ societal expectation	147	3.2	1.2	12
Pressure from green action groups	144	2.4	1.2	22
Maintaining/ presenting an environmentally/socially responsible image	145	3.8	1.0	3
Pressure from shareholders or investors	114	2.8	1.3	19
Pressure from the Insurance Industry	137	2.8	1.2	18
Competitive				
Provides operational cost savings	141	3.0	1.3	14
Provides new market opportunities	137	3.0	1.3	15
To match the activities of competitors	132	2.8	1.3	16
To perform better than our competitors or equivalent institutions	138	3.4	1.4	8
Internal [5]				
Pressure from employees	143	2.6	1.0	21
The CEO (or equivalent) commitment to environmental improvement	143	3.3	1.3	9
Culture of the organisation promotes environmental responsibility	144	3.4	1.2	7
In order to reduce the health and safety risk associated with our goods, services or operational practices	141	3.7	1.2	4
In order to reduce the public's perceived risk associated with our company	139	3.5	1.2	6

4 not answered by mainly business- to- business and public sector organisations

5 these constructs are discussed fully in chapter 8

7.3.1 Legislation

Many authors have found that compliance with environmental regulation is the most commonly cited motivation for environmental improvement. (Baylis *et al.* 1998b,c; Davis 1996; Ghobadian *et al.* 2001; Henriques and Sadorsky 1996; Lamming and Hampson 1996; Min and Galle 1997; Preuss 2001; Welford and Gouldson 1993; Zhu and Geng 2001). This is also true in the findings displayed in table 7.1 with UK legislation (mean=4.2) and EU legislation (mean=3.9) influential to *a very great extent* and ranked 1st and 2nd in table 7.1.

The perceived threat of *'future'* environmental legislation (ranked 5th) is almost as influential as actual legislation. This refers to legislation that is not currently in force but is due to affect organisations in the future, such as EU directives that have not yet been ratified into British law. The *possible threat of future legislation* is ranked 10th, suggesting again that organisations may proactively anticipate possible legislation, i.e. potential legislation that is in the discussion stage. In 1996, Davies indicated that the response of organisations to proposed product take back legislation showed that many organisations were pre-emptively anticipating environmental legislation.

Murphy *et al.* (1995), discussed in section 3.3, examines the reasons for establishing environmental policies and identifies legislation as the most influential driver (comparable with the constructs ranked 1st, 2nd and 5th in table 7.1) and the second most influential reason as *minimising environmental liabilities* (cited by 63.2% of respondents in the Murphy *et al.* study and ranked 4th and 6th in table 7.1). The Institute of Managers (1998) study, illustrated previously in table 3.2, also found that legislation was the most important driver of change in environmental behaviour in their study.

7.3.2 Societal

The majority of the societal drivers appear to be influential to a moderate extent (mean scores 2.8-3.2). The first exception is *the influence of green* *lobby groups* which has a very low level of influence and is ranked last in table 7.1. The second exception is *the pressure to maintain an environmentally responsible image* which has the highest societal score (3.8) and is ranked 3rd overall in table 7.1. By comparison, in the IM (1998) study the role of environmental pressure groups was highlighted as the fourth most influential driver, and customer opinion as the third.

This contradicts the findings in table 7.1 where *pressure from green lobby groups* is the least influential external driver and *the influence of pressure from individual consumers* is also low (ranked 17th). The sample in the IM (1998) was made up of members of a professional body from a range of sectors, in a similar manner to this study. However, this study and the IM study differ in the measurement scales used. In the IM study respondents were asked to identify their top three drivers of environmental activity in their organisation and green pressure groups was cited by 34% of respondents as one of these top three. Whereas, in this study Likert scales are used to measure the influence of each construct, so the scales are not directly comparable. In the IM study, 66% of respondents effectively stated that green pressure groups were not amongst the three most influential drivers of environmental management. In this study, 64% of respondents classed the influence of green pressure groups as not applicable, no influence at all or influential to a small extent. Therefore, comparison of the findings between the IM study and table 7.1 shows some correlation but direct comparison is affected by this difference in the way the measurement scales were used to gather the data. The findings in table 7.1 do support the findings of Florida (1996) who examined a group of US manufacturers and found that NGOs, (which would include green pressure groups), were the least influential factor affecting the development of corporate environmental strategy.

7.3.3 Supply Chain

Supply chain factors appear to be amongst the least influential external drivers (ranked 11th, 13th, 17th and 20th). The *requirements of the customers* are influential to a moderate extent (ranked 11th) compared with the *influence* *of suppliers* (ranked 20th), supporting the view of Hill (1997) discussed in section 3.3.1.3 of the relative importance of customers as greater than the influence of suppliers. Yet, these influential customers are mostly other organisations, as opposed to individual consumers. This reflects the sectoral make-up of the sample and supports the comments of Green *et al.* (1996) on the importance of inter-corporate trade. The dominance in this study by inter-corporate trade, as opposed to trade with individual members of the public, may be one of the reasons that the influence of green pressure groups is low, as discussed in the previous section.

7.3.4 Competitive

Most of the competitive drivers are influential to a moderate extent with *performing better than competitors* slightly more influential (mean 3.4) than the rest. Yet the study by Murphy *et al.* (1995), found that *performing better than competitors*' was cited by only 15% of respondents. It might be argued that in the intervening nine year period between their study and this one, high profile media exposure of poor corporate social and environmental performance (for example Shell), or poor working practices in developing countries (e.g. Nike) has led to a greater perception of the need to protect an organisation's image. In addition, individuals have access to information on companies through the internet in a manner not possible in the mid-90s when the Murphy study was published. In fact, *maintaining an environmentally responsible image* is the 3rd most important driver in this study (mean = 3.8). The recent proliferation of 'benchmarking' concepts may have led to a greater awareness of the need to match and exceed peer group performance. For instance, there are a number of indices now available on corporate social and environmental performance (CSR), such as the BiE CSR register and the Dow Jones Sustainability Index.

The role of *cost savings* from environmental management is less influential in table 7.1 than the study by Davies (1996), Murphy *et al.* (1995), Rao (2002) or Rodrigue *et al.* (2001) where cost saving was identified as a highly significant driver. The contradictory findings here perhaps reflect the dominance of manufacturing companies in all of these previous studies, where the possibility of reducing operational costs and environmental impacts by improving the environmental management of products and processes might be greater. In this study, 29.5% of the organisations are from the public sector and 10.1% from the service sector where arguably large scale cost savings through environmental improvement are less likely. However, although operational cost saving is ranked 14th in table 7.1 this still equates to a mean score of 3, suggesting that this construct is influential to at least a moderate extent.

7.4 Data Reduction and Transformation

The discussion presented in the previous section is descriptive and does not examine the extent to which external drivers may be more influential in different types of organisations, or how these different drivers interact with each other.

Therefore, the constructs in table 7.1 can be tested using statistical 'tests of difference' where the respondents are grouped into categories (like sector) and the mean scores for each category statistically tested to see if there are significant differences in a particular variable (such as legislation). It is possible to undertake tests of difference on the 17 individual constructs but this produces a vast amount of unwieldy data, likewise if the data was used to test relationships. Therefore, data reduction is required (see Tabachnick and Fidell 2001) to transform the data from the 17 constructs into a smaller number of numerical scale variables (suitable for statistical techniques such as correlation and regression).

7.4.1 Data Reduction using PCA

The external drivers of environmental behaviour are grouped into four categories of external drivers based on the discussion presented in chapter 3, and assessed in the research questionnaire using seventeen constructs (Table 7.1 illustrates the sets of constructs belonging to each group). A PCA for each group of constructs (e.g. legislation) extracts only one component, suggesting that only one dimension is being captured by the constructs aligned to that group (table 7.2). Table 7.2 illustrates the PCA results for each type of external driver[6] [7]. For example in the case of legislation all the values in the correlation matrix are above 0.3, the KMO value is 0.714 exceeding the minimum recommended value of 0.6 (Kaiser 1970; 1974) and the Bartlett's Test of Sphericity is statistically significant at $p<0.000$. The minimum communality value identified is 0.688, which suggests the data is appropriate for factor analysis. The Cronbach's alpha value is 0.8789 suggesting internal reliability of the data[8].

Table 7.2: Summary of results from PCA of external drivers

Driver	No. Items	KMO value	Bartlett's Test	Cronbach Alpha	Eigen value	% variance	Normal Dist'ed
Legislation	4	0.714	P<0.000	0.8789	2.955	73.9	No
Supply Chain	4	0.653	P<0.000	0.7738	2.204	60.1	Yes
Societal	5	0.689	P<0.000	0.8412	3.086	60.7	Yes
Competitive	4	0.786	P<0.000	0.8731	2.911	72.8	No

For the legislative constructs, the PCA analysis extracted one factor with an Eigenvalue of 2.955, which explains 73.9% of the variance. No rotation was undertaken since only one component was extracted. The resultant component scores are not normally distributed (Kolmogorov-Smirnov value of $p=0.01$)[9].

The groups of constructs measuring supply chain, competitive and societal external drivers are also all suitable for PCA and all result in one extracted factor. These results suggest that each group of constructs for each type of external driver is only measuring one concept. Therefore, the legislative, supply chain, competitive and societal constructs are all reduced into single variables.

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6 see appendix 9 for a detailed explanation of factor analysis
7 see appendix 11 for a worked example
8 see appendix 9 for an explanation of Cronbach's alpha

7.4.2 Data Reduction using Average Scores for the External Drivers

The PCA confirms that each group of constructs aligned to an external driver measures only one dimension each. This suggests that these constructs can be transformed using average scores (after Blaikie 2003) for each group of constructs aligned to each external driver (legislation, societal, supply chain and competitive). Each of the constructs measuring the external drivers are scored on a five point Likert scale, where 1=not at all, 2 = to small extent, 3 = to a moderate extent, 4 = to a great extent and 5 = to a very great extent. The total score for each of the constructs within each of the groups can be summed and divided by the total number of responses, to produce an average mean score for each type of external driver. The results from this transformation are presented in table 7.3.

Table 7.3: Results from the transformation of the constructs measuring external divers using average scores

External Driver	Mean	Std Dev.	95% CI Lower	95% CI Higher	Kolmogorov-Smirnov value	Df	Normally dist'ed
Legislation	3.72	0.96	3.57	3.88	0.00	146	No
Supply Chain	2.97	1.03	2.8	3.14	0.02	143	No
Societal	3.02	0.91	2.88	3.17	0.088	147	Yes
Competitive	3.05	1.15	2.86	3.25	0.013	141[10]	No

Blaikie (2003) adopts a similar approach, whereby average scores are produced for groups of constructs. Using the average score is preferable as the actual score conforms to the Likert scale used in the original questionnaire. However, to check the validity of this approach the PCA scales and average scores should be highly correlated. A Spearman rho correlation between the scales developed using the principal components analysis of the legislative constructs, and the average mean score for the legislative constructs, produces a rho value of 0.998 at $p<0.00$ significance. This suggests an almost perfect correlation between the two scales.

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9 The implication of non-normality of data for statistical tests is also discussed in appendix 9

10 The missing values arise from 7 public sector organisations and a bank (classed as service)

A similar pattern is found for the other driver scales, with rho values of 0.997 ($p<0.00$) for the correlation between the PCA scale and average scores for societal drivers. There is a rho value of 0.998 for the correlation between the scale variables measuring competitive drivers and a rho value of 0.996 at $p<0.00$ level for the correlation between the PCA scale and average scores for supply chain drivers. On the basis of these correlations the two scales (PCA and average score) are identical and either of these scales can be used in later statistical analysis. The scale variables developed using the average scores are used from this point onwards. Firstly, as the resultant average score for each case can be compared to the original Likert scale used in the questionnaire it is possible to assign a relative importance to the the score for each case. Secondly, the use of average scores minimises the influence of missing values. For example legislation has four constructs – if a respondent answered three of them with a score of 3 (moderately important) and did not answer the fourth construct, the average score would be 3 [3+3+3/3][11].

7.4.3 Developing a Composite Measure of External Pressure

The third type of data transformation used on the external drivers is the development of a composite measure of all the external drivers. Thus, a PCA of the societal, supply chain, competitive and legislative drivers (the average scores discussed in 7.3.2) provides an empirical summary of these scale variables. All the values in the correlation matrix were above 0.3, and the KMO value was 0.675, which exceeds the minimum recommended value of 0.6 (Kaiser 1970:1974). The Bartlett's Test of Sphericity was statistically significant at $p<0.000$. The minimum communality value identified was 0.485 and Cronbach's alpha value was 0.745 suggesting internal reliability of the data. The PCA analysis extracted one factor with an Eigenvalue of 2.303, which explained 57.57% of the variance and the resultant component scores saved as new variable (known as 'summary of external drivers'). De Vaus (2002) recommends undertaking a PCA on groups of constructs when high

11 From this point onwards legislative, competitive, supply chain and societal scales refer to these average score variables

intercorrelations may be present.

7.5 Examining the Influence of Moderating Factors on External Drivers

The composition of the sample in this study is different from the other green supply chain management studies discussed in chapter 2 and table 1.1. Therefore, this section examines the influence of organisational contingencies upon the individual variables in the green supply chain model. Seven organisational contingencies are selected to examine this effect of industry contingencies on the findings, as detailed in section 6.8[12]

7.5.1 Differences in Legislative Pressure

Sector, market type, size, possible environmental impact and risk all show statistically significant differences in the level of legislative pressure experienced by groups of organisation, when clustered according to their organisational contingencies[13], as illustrated in Table 7.4 (highlighted in bold).

Table 7.4: Significant differences between groups of organisations and level of legislative pressure

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	19.47	4	**0.001**
Size	11.83	2	**0.003**
Market Type	12.95	2	**0.002**
Supplier Dependency	1.93	2	0.380
Customer Dependency	4.82	2	0.090
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1721	5462.0	**0.000**
Possible Environmental Impact	1900.5	4903.5	**0.004**

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12 These organisational contingencies are all independent categorical variables and the scales measuring the five types of external drivers are all dependent continuous numerical variables. Therefore, the organisational contingencies with three or more categories can be tested using Kruskal Wallis test and those with two categories can be tested with the Mann-Whitney U test. If these tests show significant differences between the different organisational groups based on aspects such as their size, or sector, it suggests that these contingencies may affect the intensity of pressure that is experienced and that they may moderate the relationship in the green supply chain management pressure response model. An examination of the mean rank score establishes which group experiences the greatest and least intensity of pressure

An examination of the mean rank score for each of these statistically significant organizational contingencies indicates which groups experience the greatest amount of legislative pressure (table 7.5). The higher the mean rank score, the greater the level of legislative pressure experienced by that specific group.

Table 7.5: Examination of the different levels of legislative driver pressure in different types of organisations

Demographic Characteristics	*Values*	*N*	*Mean rank*
Sector Type	Construction, utilities, transport/logistics	23	81.4
	Public	41	89.2
	Manufacturing	44	72.4
	Mixed service/manufacturing	16	67.9
	Service & retail/wholesale	22	41.6
Market Type	Consumer/Public	47	86.5
	Mixed B2C B2B	36	81.4
	Business to Business	63	59.3
Size	Medium/small (<250)	45	55.8
	Large (250-999)	29	77.3
	Very large (1000+)	72	83.0
Potential environmental impact	Lower	77	63.9
	Higher	68	83.6
Potential Environmental Risk	Lower	86	63.5
	Higher	58	85.8

The findings in table 7.5 suggest a number of trends:

- Very large organisations perceive the greatest legislative pressure and SMEs the least;
- The public sector perceives the greatest legislative pressure, followed by the construction/ utilities/transport/logistics, manufacturing, mixed manufacturing and service, in descending order. The service/retail/wholesale sector experience the least legislative pressure;
- Organisations serving the general public and individual consumers experience the greatest amount of legislative pressure, with business-to-business organisations experiencing the least; and

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13 See appendix 11 for a worked example

- High environmental risk and impact results in greater legislative pressure.

In a study of manufacturing and process companies in South Wales (Baylis *et al.* 1998b) legislation was identified as the most important driver of environmental behaviour in organisations by both the SMEs and larger companies, but the relative level of legislative pressure was lower in the SME group than in the larger group. These findings are supported by the results in table 7.5, where the lowest mean rank score is experienced by the SME group and the highest by the very large organisations suggesting that as size increases so does the level of legislative pressure. This confirms the findings of studies such as Baylis *et al.* (1998b) and others (such as Elliot *et al.* 1996, Hillary 2000) that SMEs perceive less legislative pressure to change their environmental behaviour. This difference between large organisations and SMEs may be linked to the lower visibility of SMEs and/or perhaps the lower levels of environmental impact/ risk of the smaller group. Also many of the largest organisations are in specific sectoral groups, such as utilities, but this is not exclusively the case.

The study by Baylis *et al.* (1998c) exhibited varying levels of legislative pressure in different sectors, with the chemical and metal sector reporting high levels of legislative pressure. However their study does not use statistical tests to prove that these differences are significant, merely presenting percentage scores of the difference between sectoral groups. New *et al.* (2002) suggests that the effect of regulation on green procurement practices is greatest in the public sector organisations compared with the private sector. This is supported by the findings in table 7.5 where the highest mean rank score for the legislative drivers is found in the public sector group. Levels of bureaucracy (such as that associated with the EU Procurement Directive) are arguably higher in the public sector and this is perhaps reflected in the findings reported here. However, what is not clear is the specific nature of the legislation (e.g. the EU Procurement Directive in the public sector, Environmental Protection Act in the manufacturing sector) that is affecting these different sectors and whether this is the same across all sectors, only that the total amount of legislative pressure appears higher in the public sector. Further research is required to establish which specific legislative acts affect each industrial group.

Banerjee *et al.* (2003) compared moderate and high impact industries and found that regulatory forces were moderated by the industry type. Organisations such as construction, utilities and manufacturing might be perceived to be generally higher environmental risk/impact industries, compared with the lower risk/impact service sector. In fact, Banerjee (2003) suggests that 'dirty' industries such as chemical and utilities, are affected to a much greater extent than 'clean' industries by environmental legislation due to the costs of compliance and issues of liability. A chi-squared test of the relationship between sector and level of potential environmental risk, and potential environmental impact, are both significant (p=0.01) but it is clear from an examination of the cross-tabulation between sector and these contingencies (risk and impact), that these groups are not mutually exclusive[14]. For instance, the public sector and the construction/ utilities/ transport sector mostly class themselves as high impact but there are still organisations within these sectors that class themselves as low risk. Although the perception of environmental risk and impact are valid measures, future studies could triangulate these by adopting a single uniform measure of potential environmental risk and impact rather than using each respondent's interpretation of these measures, from additional documentary evidence and a more detailed breakdown of sectoral composition. This was not possible in this study due to the anonymous nature of the respondents.

7.5.2 Differences in Societal Pressure

Sector, market type, size, possible environmental impact and risk show statistically significant differences at p<0.01, in the level of societal pressure experienced by organisations in this study , as highlighted in table 7.6 in bold.

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[14] This data is only reported in the text and not in any of the tables and figures.

Table 7.6: Significant differences between groups of organisations and level of societal pressure

Kruskal Wallis Tests	*Chi Squared*	*Df*	*Asymp. Sig*
Sector	20.44	4	**0.001**
Size	15.15	2	**0.001**
Market Type	16.57	2	**0.000**
Supplier Dependency	2.92	2	0.141
Customer Dependency	1.38	2	0.501
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1578.5	5406.5	**0.00**
Possible Environmental Impact	1577.5	4658.5	**0.00**

When the mean rank scores for each of these statistically significant demographic characteristics are examined (table 7.7) the groups that experience the highest amount of societal pressure are identified.

Table 7.7: Examination of the different levels of societal driver pressure in different types of organisations

Demographic Characteristics	*Values*	*N*	*Mean rank*
Sector Type	Construction, utilities, transport/logistics	23	96.4
	Public	42	86.7
	Manufacturing	44	67.6
	Mixed service/manufacturing	16	60.6
	Service & retail/wholesale	22	48.8
Market Type	Consumer/Public	48	84.9
	Mixed B2C B2B	36	88.1
	Business to Business	63	57.6
Size	Medium/small (<250)	45	53.5
	Large (250-999)	29	82.9
	Very large (1000+)	73	83.1
Potential environmental impact	Lower	78	59.7
	Higher	68	89.3
Potential Environmental Risk	Lower	87	62.1
	Higher	58	89.3

The findings in table 7.7 suggest a number of trends:

- Larger organisations (250+ employees) perceive more societal pressure than SMEs;
- The Construction/utilities/transport organisations perceive the most societal pressure, followed by the Public sector, Manufacturing, mixed

Manufacturing/Service in descending order. The service/ retail/ wholesale sector experience the least societal pressure;

- Business to Business organisations perceive less pressure from societal factors than other organisational types;
- Organisations designating themselves, as higher potential environmental risk or higher potential environmental impact perceive greater societal pressure than lower environmental risk/ impact organisations; and
- Differences between organisational groups for legislative pressure (section 7.5.1) and societal pressure show similar patterns

Societal pressure is measured in this study using five constructs (detailed in table 7.1) of which *presenting an environmentally/ socially responsible image* is ranked third overall. Hoffman (1999) found that social responsibility was ranked the second most important environmental driver after regulation. In this study, the mean score for the legislative drivers (3.72) was ranked first with competitive (3.05) slightly above that of societal pressure (3.02), as detailed previously in table 7.3. However, since the societal drivers is comprised of five items of differing levels of importance (ranked 3rd, 12th, 18th, 19th, 22nd) it may be that the construct ranked 3rd (image) leads to an over-inflation of the average score for this driver. What is clear from these results is that there are significant differences between types of organisations in terms of the levels of societal pressure they experience.

Baylis *et al.* (1998b) examined the influence of organisational size on the pressure from what they define as *'good neighbourliness/ public concern'*, which is arguably similar to a measure of societal pressure as used in this study. They argued that the greater complexity and potential to pollute of large companies means that they are more visible and more likely to attract public interest. Henriques and Sadorsky (1996) who also discussed how larger firms are more susceptible to public scrutiny, also note this visibility of the larger firm. Baylis *et al.* (1998c) identified differences between sectors in terms of *'good neighbourliness/ public concern'*, with the food sector experiencing the highest level of societal pressure, followed by the chemical, metal, electrical and mechanical sectors. Arguably, the construction/ utilities/ transport sectors are amongst the most visible and in this study they experience the greatest level of societal pressure. High levels of societal pressure are also seen in the public sector, where their close proximity to the general public also makes them highly visible.

In the work by Banerjee *et al.* (2003), public concern moderated environmental behaviour in high environmental impact companies but through top management commitment (which is an internal factor in the model presented in this study and discussed more fully in the next chapter). The level of potential environmental risk and impact also affect visibility. Those organisations with very high levels of potential environmental risk/impact are going to be the focus of societal and legislative pressure because of the nature of their business activities.

The significant difference in organisational contingencies in the societal drivers mimic those of the legislative driver (table 7.5) with societal pressure greatest in the larger, higher risk and impact organisations and those serving the public or individual consumer. When correlated these two scale variables (legislative and societal) produce a value of $r = 0.648$, explaining 42% of the variance between the two scales. Sectoral differences are also apparent in both the legislative and societal drivers but societal pressure is greatest in the construction/ utilities/ transport group whereas legislative pressure is greatest in the public sector. This is perhaps reflecting the societal pressure associated with the higher risk construction, utilities and transport group and the high level of legislation associated with the public sector (particularly the influence of the EU Public Procurement Directive which is only applicable to the public sector).

Of all the external influences upon an organisation the influence of the 'societal' factors is the least tangible and most difficult to capture. It could be argued that legislation in fact reflects the values and concerns of society and as such might be a better indicator of general societal pressure than the constructs originally used in the development of the societal scale. Although the legislative and societal scales do produce a statistically significant correlation, this only explains 42% of the variance in the scales, and there still remains 58% of the variance in the variables unexplained by this linear correlation. Therefore, the societal scale is retained within the green supply chain management model to see whether it adds to the precision of the model.

7.5.3 Differences in Supply Chain Pressure

Table 7.8 indicates that only customer dependency and level of possible environmental impact show statistically significant differences ($p<0.01$) in the level of supply chain pressure experienced by organisations in the sample. The mean rank score for the group with the lowest customer dependency is 54.8, the moderate group is 79.2 and the highest dependency group is 85.1[15]. These mean ranks scores suggest as customer dependency increases so does the level of external supply chain pressure

Table 7.8: Significant differences between groups of organisations and level of supply chain pressure

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	3.00	4	0.559
Size	4.18	2	0.124
Market Type	2.67	2	0.264
Supplier Dependency	3.95	2	0.139
Customer Dependency	14.88	2	**0.001**
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	2162.5	5732.5	0.33
Possible Environmental Impact	2062.0	4912	**0.00**

In the case of customer dependency there are significant differences between groups that are highly depended on particular customers compared with those that are not. In highly dependent organisations, both supply chain and competitive pressures are greatest. In those cases where a customer requires

15 The mean rank scores for the significant organisational contingencies and supply chain pressure are only presented in the text.

environmental improvements from a supplier, over-dependence upon that customer may lead to forced rather than voluntary compliance. Customers are identified as *'powerless stakeholders'* by Fineman and Clarke (1996) in a study of environmental stakeholders in the supermarket, chemical, automotive and power generation industries suggesting that customer pressure would not be as important as other external driver like legislation. The significance of the influence of customer dependency on supply chain pressure suggests that some customers are more 'powerful' than others and that it in fact depends on the particular nature of the customer and how critical they are to the individual organisation.

The other significant organisational contingency for supply chain pressure is that of levels of environmental impact. Examination of the mean rank scores (not presented here) indicate that as the levels of impact increase, so does external supply chain pressure. This suggests that 'dirtier' industries experience more pressure through the supply chain to moderate their environmental behaviour.

7.5.4 Differences in Competitive Pressure

Table 7.9 indicates that sector, size, type of customer and level of risk and impact do not moderate the competitive driver. Competitive pressures are only significantly different in organisations that are critically dependent upon their customers (table 7.9). Those organisations that are highly customer dependent experience the greatest amount of competitive pressure (mean rank score 81.8) compared with the moderate group (79.9) and those with the lowest level of customer dependency (55.1). These findings are identical to the influence of supply chain pressures discussed in the previous section.

Table 7.9: : Significant differences between groups of organisations and level of competitive pressure

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	2.74	4	0.602
Size	3.51	2	0.173
Market Type	2.53	2	0.283
Supplier Dependency	2.95	2	0.282
Customer Dependency	14.13	2	**0.001**
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	2015	5510	0.18
Possible Environmental Impact	1971	4821	0.051

The perceived level of external pressure from the supply chain, societal, legislative and competitive drivers does not significantly differ in organisations that are critically dependent upon a *supplier.* This is perhaps not unexpected since supplier dependency might be considered more of an internal constraint, rather than affecting externally imposed pressures. Both the supplier and customer dependency findings for the competitive and supply chain drivers suggest that more pressure is experienced by those organisations that are highly dependent upon a customer, but that dependency upon a supplier does not lead to statistically significant differences in external driver pressures.

Baylis *et al.* (1998b) found that the motivation to reduce costs was different between their SME group and larger organisations. However, in this study a cross tabulation between the construct '*provides operational cost savings*' (used in the development of the competitive factors scale in this study) and organisational size does not produce a significant difference between SMEs (<250) and large (>250) organisations (r=0.074). Yet, an examination of the 'original' constructs forming the competitive driver scale does show trends, with operational costs savings from environmental management increasing as organisational size increases, but this increase is not statistically significant. This suggests that larger organisations are more likely to experience operational cost savings from changes in environmental operational practices, but this is not a universal effect.

Figure 7.2 illustrates the variability in levels of competitive pressure according to sector, but again this difference is not statistically significant. The lowest mean scores are for the retail/ wholesale group (2.68), then service (2.82), utilities (2.90) and public (2.94). All of these industrial groups are arguably affected less by competitive factors associated with environmental improvements. Although sectors such as the public sector are highly regulated and bureaucratic they face no competitive pressure to match their standards to others in their peer group, and the type of products and services they consume are of a lower order of environmental impact than sectors such as manufacturing.

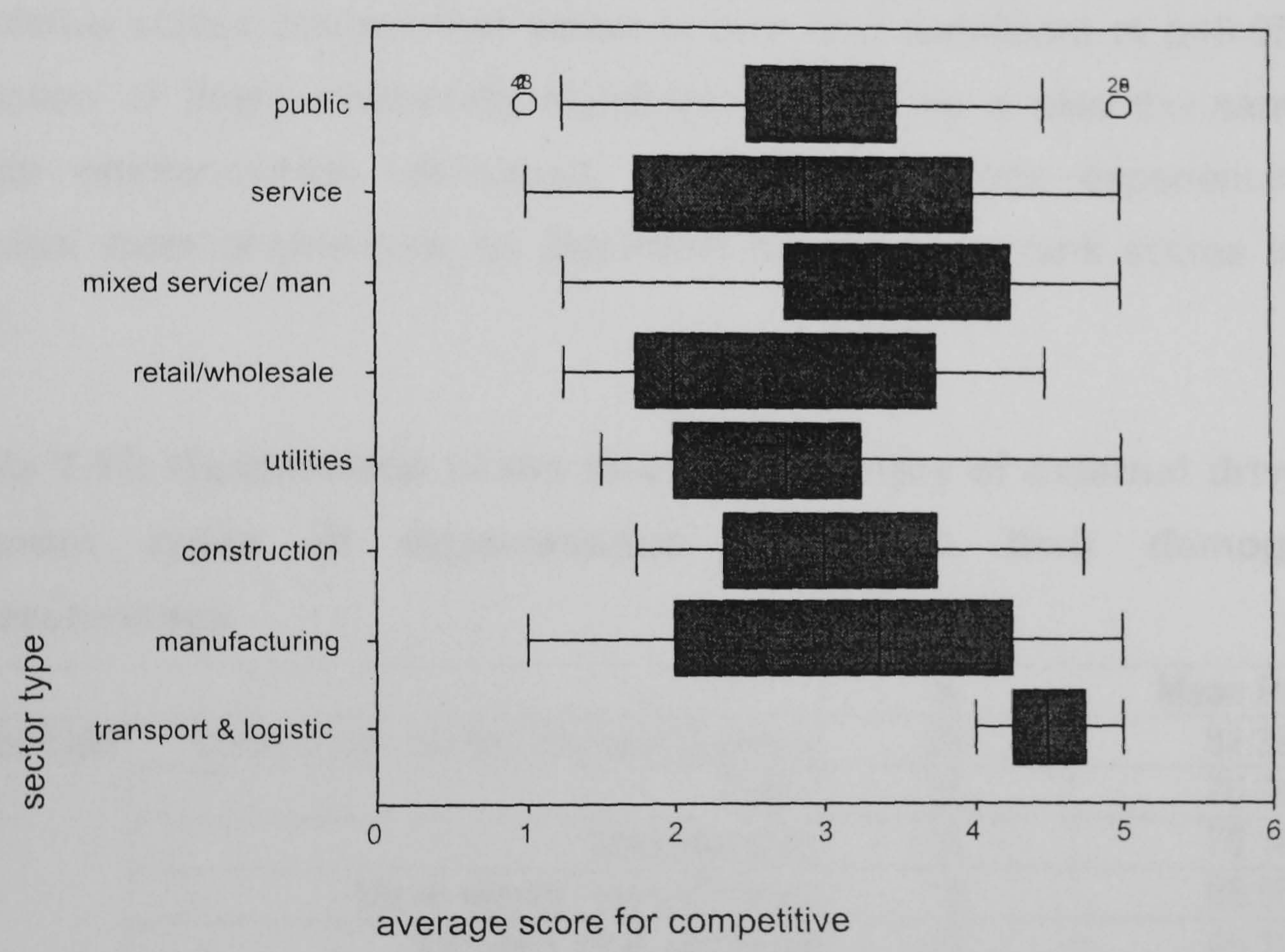


Figure 7.2: Boxplots for levels of competitive pressures according to sector

7.5.5 Summary of External Drivers

Table 7.10 presents the results of the statistical tests of difference between levels of the composite *summary of external drivers* developed in section 7.4.3, in different groups when the sample is clustered according to their organisational contingencies.

Table 7.10: Significant differences between groups of organisations and levels of environmental pressure (summary)

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	11.51	4	0.021
Size	9.86	2	**0.007**
Market Type	10.13	2	**0.006**
Supplier Dependency	3.44	2	0.179
Customer Dependency	3.62	2	0.164
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1563	4884	**0.00**
Possible Environmental Impact	1536	4237	**0.00**

The findings in table 7.10 are virtually identical to those for the societal and legislative scales (except that sector is now only significant at $p<0.05$). The 'direction' of these statistically significant differences is also the same with higher environmental risk/impact, larger, organisations experiencing the greatest external pressure, as illustrated by the mean rank scores in table 7.11.

Table 7.11: Examination of the level of 'summary of external drivers' in different types of organisations based on their demographic characteristics

		N	Mean Rank
Sector Type	Construction, utilities, transport/logistics	23	84.39
	Public	35	76.74
	Manufacturing	44	70.14
	Mixed service/ manufacturing	16	65.56
	Service & retail/wholesale	21	46.10
Market Type	Consumer/ public	41	75.05
	Mixed B2B and B2C	35	84.46
	Business to business	63	58.68
Size	Small/medium	45	54.71
	Large	28	80.61
	Very large	66	75.92
Env Impact	Lower	73	58.04
	Higher	65	82.37
Env. Risk	Lower	81	60.30
	Higher	56	81.59

7.6 Summary

Figure 7.3 illustrates the distribution of all of the individual external driver scale variables, and confirms that the perceived pressure exerted by legislation is greater than all the other external drivers. This diagram also presents a summary of the distribution of each of the external driver scales, as discussed individually in section 7.5.

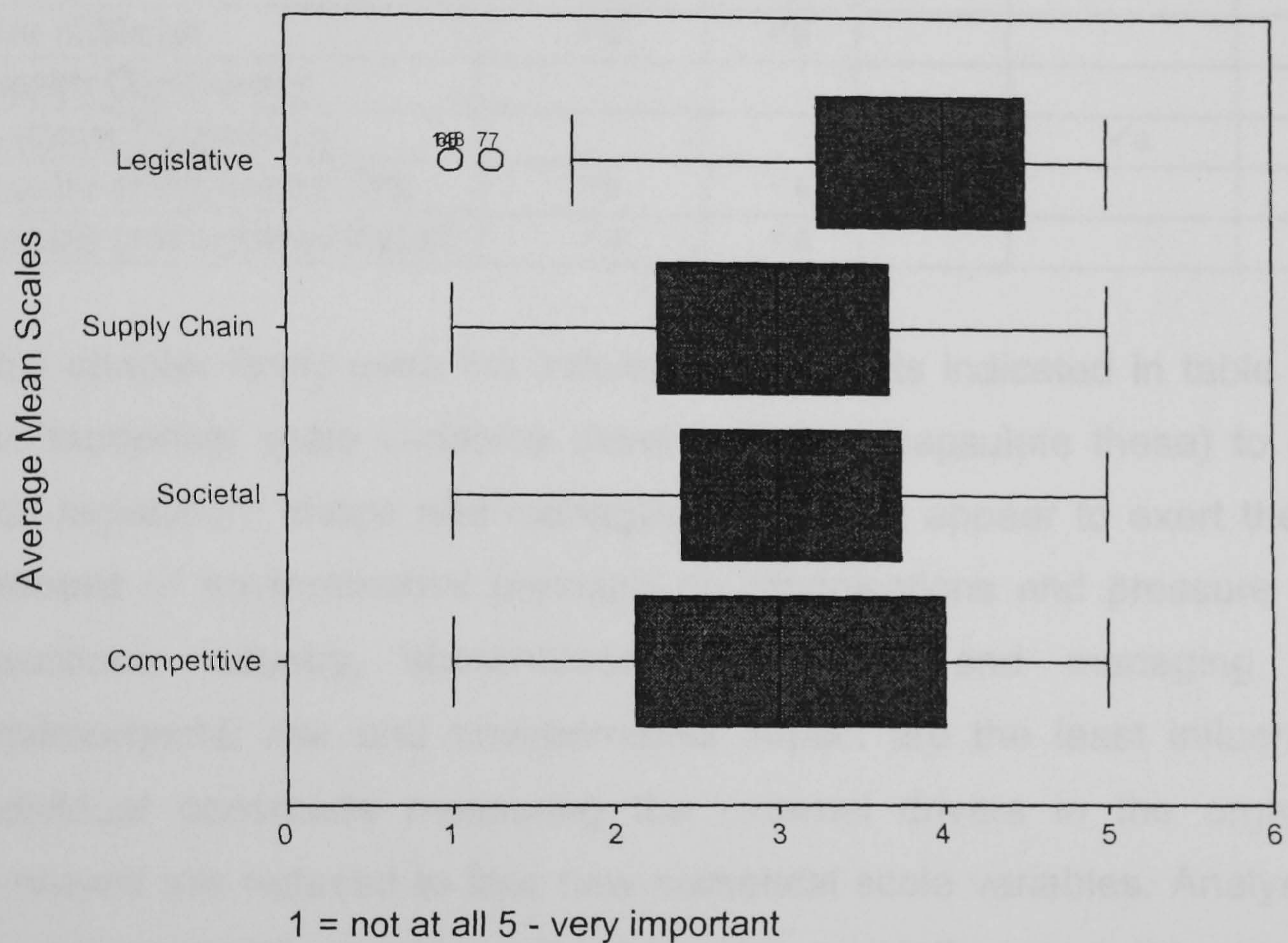


Figure 7.3: Boxplots of average scores for the groups of external drivers

Table 7.12 illustrates the influence of organisational contingencies on these external drivers and indicates that some of these contingencies do affect the intensity of some of the external drivers. Legislative and societal drivers are affected to the greatest extent by the type of respondents, whereas the competitive and supply chain factors have a more homogeneous effect affecting all types of organisations equally.

Table 7.12: Detailed exploration of differences between demographic characteristics and average scores for all the external drivers scale variables

✓a significant at $p < 0.01$ ✓b significant at $p < 0.05$

Demographic Characteristics	Legislative	Societal	Supply Chain	Competitive	External Summary
Sector	✓a	✓a			✓b
Size	✓a	✓a			✓a
Type of Market	✓a	✓a			✓a
Supplier Dependency					
Customer Dependency			✓a	✓a	
Possible environmental Risk	✓a	✓a			✓a
Possible environmental Impact	✓a	✓a			✓a

This chapter firstly uses the individual constructs indicated in table 7.1 (and the numerical scale variables developed to encapsulate these) to establish that legislation, image and managing *actual* risk appear to exert the highest **amount** of environmental pressure on organisations and pressure from the insurance industry, shareholders, employees and managing potential environmental risk and environmental impact are the least influential. The individual constructs measuring the external drivers in the organisations surveyed are reduced to four new numerical scale variables. Analysis of the 'average scores' variables measuring the legislative, societal, supply chain and competitive factors appear to indicate that some of the organisational contingencies of the respondents appear to affect the **level** of pressure experienced by difference organisational groups for each of these external drivers. The composite measure of the *summary of external pressure* perceived by the respondents is developed also identifies significant differences between types of organisations clustered according to their size, sector, market type, level of potential environmental risk and potential environmental impact, and these results mirror the findings from the legislative and societal drivers (section 7.5.1 and 7.5.2).

However, what the analysis in this chapter does not establish is whether the different levels of external pressure experienced by different types of organisations actually lead to **differences** in green supply chain management operational practices. This is examined further in chapter 9. This chapter has examined only the 'external' drivers of environmental management, whereas the next chapter (chapter 8) now examines the internal factors in the green supply chain pressure/response model.

CHAPTER 8: INTERNAL FACTORS AFFECTING GREEN SUPPLY CHAIN MANAGEMENT.

8.1 Introduction

Halme (2002) suggests that external environmental pressure sets into motion environmental management activities but that it is not this pressure alone that results in an environmental paradigm shift. Bowen *et al.* (2001b) also argue that the implementation of green supply chain management is better explained by focussing on the development and deployment of specialised internal resources and capabilities, rather than the influence of external pressures. Therefore, the green supply chain management pressure/response model examined in this study also needs to explore the influence of internal factors, such as the 'environmental culture' of the organisation and its actors. In fact, Carter and Carter (1998) recommend exactly this in future studies of environmental purchasing determinants after their examination of the drivers controlling environmental purchasing amongst a sample of US companies.

Thus, this chapter examines the second element of the green supply chain management pressure response model (as illustrated in section 3.3.2.2), namely the internal factors comprising of the three aspects of internal drivers, environmental attitude, and obstacles to green supply. The internal drivers are the first of the internal factors within the model that are examined (introduced along with the external drivers in table 7.1 in the previous chapter). This chapter examines these internal drivers in more detail and presents a transformation of these constructs into a numerical scale variable that measures the totality of the influence of internal drivers, in the same manner as the external drivers were examined in the previous chapter (section 7.4).

The second aspect of the internal factors within the pressure response model is the concept of the 'environmental attitude' of the organisation. The variable measuring environmental attitude is adapted from the work of Murphy *et al.* (1996), producing a composite percentage measure based on the response to four indicator questions, introduced in section 3.3.2.2.

The third aspect of the internal factors within the pressure response model are the possible obstacles to green supply, developed using seven constructs, in a similar manner to the development of the internal and external driver scales. A PCA on these seven constructs suggests that there are two dimensions to the data (internally focussed obstacles and supplier-orientated obstacles). Each construct loads upon one of these two dimensions and is used to develop average scores for each case. The data transformation process for the internal factors is summarised in figure 8.1.

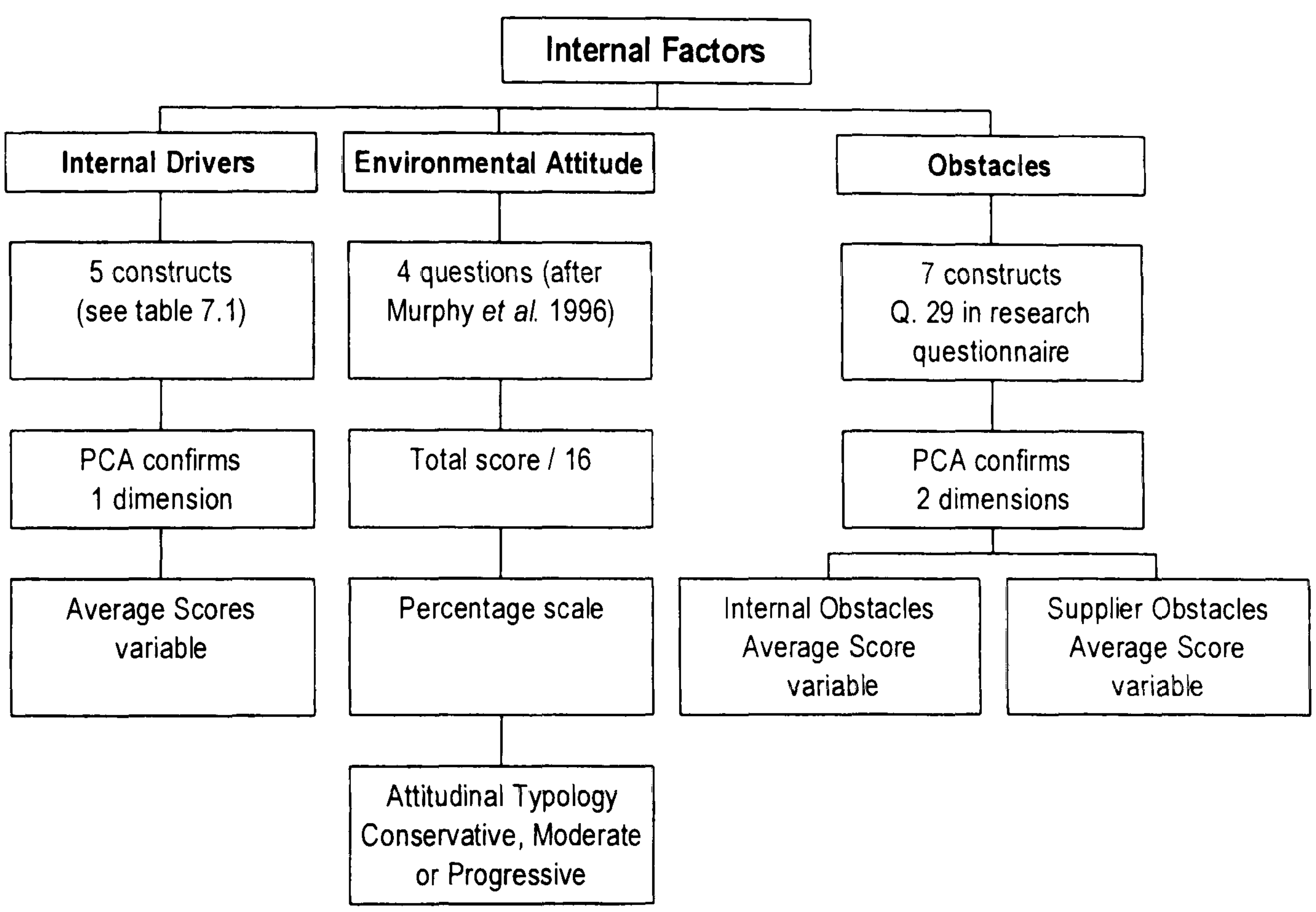


Figure 8.1: Data transformation process for the internal factors within the green supply chain management pressure/response model

Therefore this chapter:

- Presents a brief description of the three aspects used to examine the internal factors in the pressure/ response model – internal drivers, environmental attitude, and obstacles (section 8.1);

- Presents the transformation of the measures of the internal drivers, environmental attitude, and obstacles to green supply into numerical scale variables (section 8.2);
- Examines the findings for the internal drivers (section 8.3);
- Examines the findings for the environmental attitude (section 8.4);
- Examines the findings for obstacles to green supply (section 8.5); and
- Summarises the significant differences found between types of organisations clustered according to their organisational contingencies and the scale variables measuring the internal factors (section 8.6).

8.2 Transforming the variables measuring the Internal Factors

This section examines the transformation of the raw data measuring the internal factors (internal drivers, environmental attitude and obstacles to green supply) into numerical scale variables suitable for advanced statistical analysis.

8.2.1 Internal Drivers

The research instrument contains 22 constructs that measure the external and internal drivers of environmental management[1]. The seventeen external drivers were explored in detail in the previous chapter. The remaining five internal drivers (as identified in summary in table 7.1) are transformed to a single numerical scale variable, in the same manner as the development of the PCA and average scores in chapter 7[2].

The five constructs that examine the role of internal pressures in driving environmental management activity are assessed for their suitability for PCA. All the values in the correlation matrix are above 0.3. The KMO value is 0.770, which exceeds the minimum recommended value of 0.6. The Bartlett's Test of Sphericity is statistically significant at $p<0.000$. The

1 The final version of the questionnaire is presented in appendix 8
2 see appendix 11 for a worked example

communality values are all high, with a minimum score of 0.521. The Cronbach's alpha value is 0.8093 pointing to the internal reliability of the data. The PCA analysis extracts one component with an Eigenvalue of 3.709, which explains 61.6% of the variance (table 8.1). No rotation is undertaken since only one component is extracted. The resultant component scores are not normally distributed (Kolmogorov-Smirnov value of p=0.037).

Table 8.1: PCA results for internal drivers

Driver	No. Items	KMO value	Bartlett's Test	Cronbach's Alpha	Eigen value	% variance	Normal Distributed
Internal Drivers	5	0.770	0.00	0.8093	3.709	61.6	No

The scale variable developed to measure the average scores for the internal drivers is examined in table 8.2.

Table 8.2: Results from the transformation of the Items measuring external drivers using average scores

	Mean	Std Deviation	95% Confidence Limits Lower	95% CI Higher	Kolmogorov-Smirnov	Degrees of freedom	Normal distributed
Internal Drivers	3.35	0.92	3.19	3.50	0.025	142	No

A correlation between the PCA scale developed to measure the internal drivers (table 8.1) and the average scores developed to measure the same items (table 8.2) has a Pearson's correlation coefficient of 0.981 which is statistically significant at p<0.00. This confirms that both scales measure the same concept, and that either can be used in further analysis. The PCA confirms that there is only one component or dimension being measured and in further analysis the average scores for the internal drivers are used (after Blaikie 2003). The use of the average scores allows the findings to be examined for each case, in light of the Likert scale originally used to collect the raw data.

8.2.2 Environmental Attitude

Aspects such as the internal environmental culture of an organisation might not be fully captured by the internal driver constructs in the research instrument, as the internal dynamics of each case are extremely difficult to identify and measure without detailed case study work. Alternatively, publicly available environmental policies can be analysed to assess the strategic approach to environmental issues of each organisation (in a similar manner to Henriques and Sadorsky 1999) and validate the results from a questionnaire. Holt and Anthony (2000) use environmental policies as 'artefacts of culture', (after Schein 1985), to assess the convergence between corporate and employee environmental values. Since the respondents in this sample were potentially anonymous it was not possible to do this, and publication of an environmental policy is voluntary for UK organisations. Therefore, it is important to validate the internal factors driving environmental management using additional measures. This is where the concept of 'environmental attitude' might be used to encapsulate the overall environmental culture of the organisation, and possibly act as a surrogate measure of internal factors, based on a series of indicator questions (table 8.3).

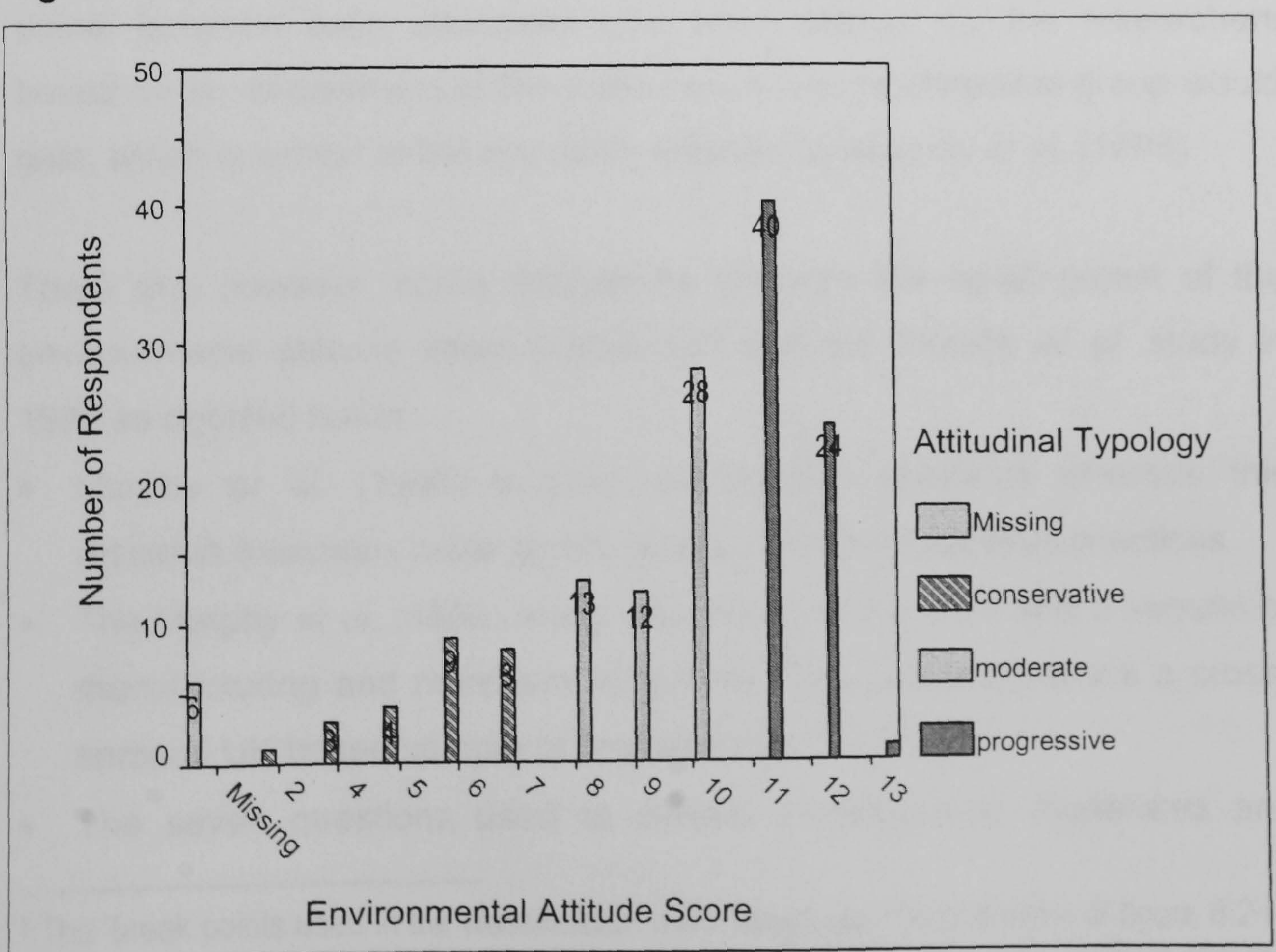
Chapter 3 discusses the use of a surrogate measure of environmental culture through an 'environmental attitude' variable developed in the same manner as a similar measure by Murphy *et al.* (1996) (see section 3.3.2.2). Developing a measure of environmental attitude involves assessment of the cumulative environmental attitudinal score, based on the scoring system identified in table 8.3.

Table 8.3: Criteria used to classify organisations as Progressives, Moderates or Conservatives (adapted from Murphy *et al.* 1996)

No.	*Focus*	*Possible response and score allocated (in brackets)*
1	General importance of environmental issues	(4) Extremely important (3) Important (2) of moderate importance (1) of slight importance (0) of no importance
2	Importance of environmental issues and how this will change over time	(3) Increase (2) Stay the same (1) decrease
3	Which of the following most accurately describes your organisations environmental policy	(3) formal environmental policy and guidelines (1) informal environmental policy and guidelines (0) no specific environmental policy
4	The extent to which environmental issues are considered in purchasing and logistics	(3) above that of other factors (2) equal consideration (1) secondary consideration (0) not considered during purchasing and logistics (0) Not considered at all

The distribution of the environmental attitude scores based upon the criteria established in table 8.3, are illustrated in figure 8.2. The score given for environmental attitude can be used to cluster respondents into attitudinal types of moderate, conservative or progressive.

Figure 8.2: Distribution of environmental attitudinal scores.



Organisations are classed as *progressives* if they gain a cumulative score of 11 or above, *moderates* score between 8-10 and *conservatives* 7 or below (after Murphy *et al.* 1996). The minimum score achieved by an organisation is 2 and the maximum is 13 from a possible 13 (see table 8.3). Six cases are excluded from the data set due to missing values that may give artificially low scores for these organisations. The cut-off points between the three classifications are based on the judgement of the researcher, in a similar manner to the prior work by Murphy *et al.* (1996)[3].

Henriques and Sadorsky (1999) also use information about the extent to which an organisation has developed and communicated their environmental policy, to cluster a sample 400 of large Canadian firms. In their study, statistical analysis through K-cluster means were used to separate the groups in rank order and then the characteristics of each cluster examined to define them. These four clusters were defined as reactive (no environmental strategies), defensive (informal environmental policies), accommodative (formalised environmental strategies) and proactive (advanced environmental strategies). In this study the break points between each attitudinal type were defined by the researchers based on an assessment of the scores each type of attitudinal group would gain, which is similar to the approach adopted by Murphy *et al.* (1996).

There are, however, some differences between the development of the environmental attitude score (figure 8.2) and the Murphy *et al.* study in 1996 as detailed below.

- Murphy *et al.* (1996) focused on logistics practices whereas this research examines wider green supply chain management practices.
- The Murphy *et al.* (1996) study was based in the USA and a sample of manufacturing and merchandising firms. This study examines a cross-sectoral UK based sample of organisations.
- The seven questions used to classify progressives, moderates and

3 The 'break points used in the classification were based upon examination of figure 8.2 to identify clusters and an assessment of the typical score on each of the four criteria that the most and least progressive would obtain

conservatives in the Murphy *et al.* (1996) study are partially replicated in this study. Four of these questions are used to develop the attitudinal score and typology within this research (table 8.3). Specifically question 1 is identical[4], question 2 is identical, question 3 is identical, and question 4 is adapted[5] [6].

- Use of the Scheffe post-hoc test for significance instead of the Duncan multiple range tests used in the Murphy *et al.* (1996) study [7]
- The relative importance of individual specific environmental issues is not assessed in this study, as it was in the Murphy *et al.* (1996) study.

There are 65 progressive organisations comprising of 45.5% of the sample. Typically these organisations believe that managing environmental issues is extremely or very important to their organisations. Progressives believe that the importance of environmental issues will increase over time and tend to have formal environmental policies and consider environmental issues above or equal to other factors when making purchasing and logistical decisions.

There are 25 (17.5%) conservative organisations and these organisations have a belief that managing environmental issues is of slight, or no importance. Conservatives tend to believe that the importance of managing environmental issues will stay the same over time and tend to have informal environmental policies (or no environmental policies). Conservatives tend to consider environmental issues below those of other

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[4] The response scale is slightly different

[5] In the Murphy *et al.* (1996) study the question identified the role of the logistics department for formulating and establishing environmental policy whilst the questionnaire used here assessed the role that environmental issues had in the decisions made in purchasing and logistics

[6] Q13 within the questionnaire was also adapted from the Murphy *et al.* (1996) study (examining the length of the environmental policy) but it was decided not to use this within the criteria used to develop the attitudinal score as many of the respondents who had formal policies did not answer this question.

[7] When assessing statistically significant differences in a one way ANOVA the Scheffe post-hoc test is recommended to identify which groups are significantly different, as this test is the most conservative, least likely to find significant differences between groups and make a Type I error (Bryman and Cramer 2001).

factors when making purchasing and logistical decisions, or do not consider environmental issues at all.

There are 53 moderate organisations (37.1% of the sample). Moderates occupy a middle position between the other two-attitudinal groups and believe that managing environmental issues is important or moderately important. Moderates tend to believe that this importance will stay the same over time and use a mixture of formal and informal environmental policies. Most moderates consider environmental issues of secondary or equal importance, to other factors when making purchasing and logistical decisions.

For the purposes of statistical analysis the cumulative score for environmental attitude is converted into a percentage. This allows comparison with the management practices scale variables (developed in the next chapter), which are also converted into percentage scales, in order to improve the interpretation of the regression equations developed in chapter 10. In addition, some of the statistical tests compare findings between different attitudinal types (i.e. progressive, moderate and conservative)[8].

8.2.2.1 Comparing environmental attitude with internal drivers

In the preceding sections, a scale variable to measure the internal drivers and a scale variable to measure environmental attitude were developed. The presumption that is made when developing an environmental attitude variable is that there are aspects of internal organisational influences that may not be totally captured by the five constructs used to assess the internal drivers. If the 'internal drivers' and 'environmental attitude' scales are the same, then a linear regression between the two should produce a perfect correlation.

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[8] The purpose of using the attitudinal typology is twofold. Firstly tests of difference such as Kruskal Wallis and ANOVA require 'groups' of organisations. Secondly, the Murphy *et al.* (1996) study discussed their findings in light of this same attitudinal typology.

The Pearson r-value of 0.479 indicates that there is not a perfect straight-line relationship between these two measures, with only 22% of the variance in the sample explained by a linear relationship between these two variables ($R^2 = 0.224$). These findings suggest that the environmental attitude variable and the internal driver variable, measure different aspects of the internal organisational culture and internal pressure to adopt green supply chain management practices. Therefore, both measures are retained within the green supply chain management pressure/response model.

8.2.3 Obstacles to Green Supply

Seven constructs are used in the questionnaire to assess the obstacles to green supply chain management. These constructs are assessed for their suitability for PCA. Six of the 49 values in the correlation matrix are below 0.3. The KMO value is 0.780, which is acceptable (after Kaiser 1974). The Bartlett's Test of Sphericity is statistically significant at $p<0.000$. The communality values are all relatively high with a minimum value of 0.545. The Cronbach's alpha value is 0.8134 suggesting internal reliability of the data. The PCA analysis extracts two components explaining a total variance of 67.6%, using a direct oblimin rotation (table 8.4)[9].

This PCA confirms that there are two dimensions within the data and which of the seven individual constructs are associated with each dimension/component. The first component loads most strongly on items associated with internal green supply chain management capabilities, whereas the second component loads most strongly on supplier associated obstacles. Both of the resultant factor scores are not normally distributed. Using the identification of each construct as either *supplier* or *internal*

[9] Direct Oblimin selected as method of extraction (after Blaikie 2003). Tabachnick and Fidell (2001: 618) state that in practice the difference between methods of extraction and rotation are slight. The solution for the obstacles was generated after multiple tests with different rotation methods to select the most consistent solution (Tabachnick and Fidell 2001).

obstacles, the average scores for each of the two scales is developed, using the average score of the four constructs measuring internal obstacles and the three constructs measuring supplier associated obstacles.

Table 8.4: Rotated component matrix and loadings for obstacles of green supply chain management

Items in Original Survey	Components	
	Internal	Supplier
Lack of financial benefit/ profit from operating a green supply chain	**0.71**	0.14
Lack of managerial commitment to green supply chain management	**0.93**	-0.09
Suppliers lack environmental awareness of our needs	-0.16	**0.77**
Company wide indifference	**0.89**	-0.08
Lack of trained personnel to implement such schemes	**0.511**	0.508
Uncertainty of the availability of appropriate environmentally 'friendly' resources from suppliers	0.02	**0.84**
Difficulty in assessing supplier's environmental and ethical performance in an efficient and cost effective manner	0.19	**0.72**
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalisation. Rotation converged in 6 iterations.		

Thus, two separate scales are developed for each group of obstacles (supplier and internal). In order to decide whether to use the PCA values or the average scores in later statistical analysis a correlation between these two scales (PCA and average scores), can assess whether they are in fact measuring the same concepts. Therefore, a correlation between the internal obstacles PCA and average scores variables produces a Pearson correlation coefficient of 0.986 and a linear relationship is established that explains 97.2% of the variance between the two scales. A similar relationship exists for the two scales measuring supplier obstacles, with a Pearson's correlation coefficient of 0.984. These findings confirm that both measures of each type of obstacle are virtually identical and that either type of scale variable can now be used. The average scores for supplier obstacles and internal obstacles are selected for used in later statistical analysis, as they can be compared with the original Likert scale used in the questionnaire.

Having developed scale variables that measure the internal drivers, environmental attitude, internal obstacles and supplier obstacles this chapter now examines each one of these in turn. Firstly a descriptive overview of the findings is explored, followed by an examination of the influence of the moderating effect of the organisational contingencies.

8.3 Examination of the Internal Drivers

Firstly, the internal drivers are examined in more detail. The five constructs used to develop the scale variable for internal drivers are examined individually in section 8.3.1, followed by an exploration of the variability in the internal driver scale depending upon organisational type (section 8.3.2).

8.3.1 Overview of Individual Internal Driver Constructs

The five internal drivers constructs are introduced briefly in chapter 7, (table 7.1), in order to compare them with the external drivers. This section now examines these in more detail and table 8.5 summarises the descriptive information for each of the internal driver constructs.

Table 8.5: Pressure experienced by organisations from Internal Drivers

Internal Driver Constructs	Number Responses	Mean	Std. Deviation	Rank Order
Pressure from employees	143	2.6	1.0	21
The CEO (or equivalent) commitment to environmental improvement	143	3.3	1.3	9
Culture of the organisation promotes environmental responsibility	144	3.4	1.2	7
In order to reduce the health and safety risk associated with our goods, services or operational practices	141	3.7	1.2	4
In order to reduce the public's perceived risk associated with our company	139	3.5	1.2	6

Pressure from employees is amongst the least influential drivers of environmental management (ranked 21st from a possible 22)[10]. Reducing

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[10] The rank order refer to the position of each of the internal construct relative to all 22

actual and perceived environmental risk are ranked 4th and 6th respectively, behind legislative pressure and pressure to maintain an environmentally responsible image. The commitment of the CEO (or equivalent) is also important to a moderate extent (ranked 9th), as well as having an organisational culture that promotes environmental responsibility (ranked 7th).

Henriques and Sadorsky (1999) identified four critical environmental stakeholder groups that influence the adoption of environmental management practices. Three of these stakeholder groups (regulators, community and media) could be classed as 'external' stakeholders, but the fourth influential group are 'organisational stakeholders'. These are stakeholders that are defined by Hall (2001) as 'actors' directly related to a company with a possible financial impact, including customers, suppliers, employees and shareholders (after Henriques and Sadorsky 1999).

However, in this study these organisational stakeholders (as defined by Hall 2000) are included as part of the competitive external driver (the customers), supply chain drivers (suppliers), societal (shareholders), and internal drivers (employees). The broad approach of Henriques and Sadorsky (1999) and Hall (2001) in groupings these organisational stakeholders together may obscure subtle differences between them. For instance, the apparent difference between the relative influence of the employees (ranked 21st) and management function (ranked 9th) suggests that different employee groups will exert different levels of internal environment pressure on an organisation, related perhaps to their own level of 'power'. Employee pressure is cited by only 11% of respondents as a main driver of environmental management in the Institute of Management 1998 study, ranked 10th from a possible 13 compared with the influence of top management which was ranked 6th. A study of US manufacturers examined the influence of different organisational actors and found that top management was classed as the most influential group of actors, followed by engineers, line workers and then R&D staff (Florida 1996). A study of

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internal and external drivers – see table 7.1

SME and large firms in South Wales found that employee concerns were ranked as the fifth most important environmental driver of environmental management in the sample of SMEs, and ranked sixth in the larger sized group (Baylis *et al.* 1998a), with legislation, reducing costs, societal concerns and personal values all ranked as more influential drivers. However this study did not look at different groups of employees and did not examine top management support as a separate criterion. Yet, Hill (1997) identified pressure from employees as an important stimuli for environmental change, with 73.4% of manufacturing firms in Yorkshire and Humberside (n=301) identifying pressure from employees as important. The Institute of Managers (1998) study also identified the Board/Top management team as a main driver of environmental change in organisations by 18% of respondents. Murphy *et al.* (1994) identifies top management support as a guiding principle in the development of successful reverse logistics programmes.

The findings in table 8.5 indicate that the CEO or equivalent may be a moderately important driver of environmental change. In fact 55 of the 62 environmentally 'progressive' organisations stated that the CEO plays a moderate, important or very important role in driving environmental change. A study by Gavaghan *et al.* (1998) of 20 leading environmental 'best practice' companies in green supply chain management identified environmentally committed top level management as a key common trait in such firms.

Ogbonna and Harris (2001) examine the influence of founder ideals and how these shape future strategic decision-making. It might be argued that if the founders or highly influential CEO's exhibit strong environmental values these might endure as a legacy within the organisation. Waldman *et al.* (2001) explore the concept of leadership charisma suggesting that such leaders develop high levels of 'collective cohesion' and this may influence performance under conditions of perceived uncertainty.

Therefore, the personal 'environmental values' of leaders within an organisation may influence the adoption of environmental management practices. Weaver *et al.* (1999:44) also notes the importance of the personal values of the CEO, suggesting that the strong social values of the CEO of Levi-Strauss have resulted in their strong environmental ethical stance. Ghobadian *et al.* (1998, 2001) found that the environmental strategy of an organisation is mediated by the attitudes of its managers. Bowen *et al.* (2001a) found a general pattern that units with high environmental commitment amongst personnel were more likely to follow a proactive green supply chain programme, but that this was most pronounced when the top management was environmentally committed. Yet, Schaper (2002) examined the personal beliefs of the owners/ managers of retail pharmacies in Australia and found that personal beliefs were not positively related to environmental performance (at $p<0.05$). In the Carter *et al.* (1998) study top management support was not found to be significantly related to green purchasing activity but the support of middle management was ($p=0.01$).

The successful adoption of environmental management programmes may not be related to management, employees or the CEO but a specific individual. Fineman and Clarke (1996) note the positive influence of internal 'champions', (so-called 'green champions') with more senior internal champions having the greatest impact, which links into the importance of founders or charismatic CEOs (Ogbonna and Harris 2001; Waldman *et al.* 2001). In comparison, Drumwright (1994) found that environmental policy entrepreneurs in middle management positions were more influential than those at the top.

The contradictory findings from these previous studies and the results presented in table 8.5 support the assertion by Fineman and Clarke (1996:717) that *'internal stakeholders do not necessarily have a common view of the significance the firm should attach to environmental issues'*. Fineman and Clarke (1996) identified employees as *'powerless stakeholders'* in their study of UK supermarkets, automotive, power generation and chemical companies (n=24). In the findings reported in table 8.5 the employees do appear to hold a powerless position as the least influential driver apart from the green pressure groups. Whereas, the top management function appears to be amongst the most influential drivers.

These previous studies predominantly suggest that different types of employees at different hierarchical levels in an organisation exert different levels of internal pressure to change environmental behaviour. This study did not examine the personal views of the respondents, or establish the level of personal environmental commitment of the CEO or any 'green champions' within the organisation. Further work would be necessary to specifically examine the influential actors in progressive organisations and how influential they have been at driving environmental management initiatives. This level of detail might best be examined by further detailed case study analysis and this is precluded in this specific study due to the potentially anonymous nature of the respondents

However, the focus should not necessarily be on individual organisational actors but on the overall environmental ethos of the organisation, that remains in place irrespective of the personnel employed. Halme (2002) examined the development of an environmental paradigm shift in two Finnish firms, concluding that generating managerial beliefs that include environmental criteria in corporate decision making was a matter of 'learning' and in order for the organisation to learn new environmental core values (i.e. those that will be embedded in the organisations culture), the entire organisation must directly engage in practical environmental activity to fully engage with a new environmental cultural 'mindset'. Halme's (2002) study examined the detailed experiences of different organisational actors. Such complex, interwoven, 'learning' experiences are not captured by the survey-based research undertaken for this study, again suggesting the need for a surrogate measure that may capture the totality of the influence of different groups of organisational actors. This is perhaps where a measure of '*environmental attitude*' (after Murphy *et al.* 1996) may provide fruitful avenues to explore (examined further in section 8.4).

8.3.2 The influence of Organisational Contingencies as Modifying Factors on Internal Drivers

This next section examines the influence of different organisational contingencies on the intensity of the internal drivers experienced by the respondents. An examination of the internal drivers indicates that statistically significant differences at $p<0.01$ exist between organisations when clustered according to their sector, size, level of environmental risk and level of environmental impact (table 8.6).[11]

Table 8.6: Significant differences between groups of organisations and level of internal drivers

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	18.83	4	**0.01**
Size	9.58	2	**0.01**
Market Type	10.16	2	0.06
Supplier Dependency	3.31	2	0.19
Customer Dependency	5.642	2	0.06
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1736	5306	**0.01**
Possible Environmental Impact	1563	4489	**0.00**

An examination of the mean rank score for each of these statistically significant contingencies indicates which organisational groups experience the greatest amount of internal environmental pressure (table 8.7). The higher the mean rank score, the greater the level of internal pressure experienced by that specific group.

Tables 8.6 and 8.7 suggest a number of trends in internal driver pressure in the organisations surveyed:

- Larger organisations experience more internal pressure to adopt environmental management practices than small/ medium organisations;
- Some sectors experience significantly more internal pressure than other sectors; and

[11] See appendix 11 for a full explanation of the Kruskal Wallis, Mann Whitney tests and the importance of mean rank scores

- Organisations with higher levels of potential environmental risk or environmental impact experience greater levels of internal pressure (in the same manner as the legislative and societal drivers in the previous chapter).

Table 8.7: Examination of the different levels of internal driver pressure in different types of organisations

		N	Mean rank
Sector Type	Construction, utilities, transport/logistics	23	91.24
	Public	39	80.09
	Manufacturing	44	70.75
	Mixed service/manufacturing	15	63.07
	Service & retail/wholesale	21	41.52
Size	Medium/small (<250)	45	56.56
	Large (250-999)	27	84.69
	Very large (1000+)	70	76.02
Potential environmental impact	Lower	76	59.07
	Higher	65	84.95
Potential Environmental Risk	Lower	84	63.17
	Higher	56	81.50

As illustrated in table 8.7, the smallest organisations experience less pressure from the internal drivers than the large organisations (250+ employees). However, the very largest organisations (1000+) appear to be less influenced by internal drivers than the large group (250-999). A Mann Whitney U test of large (250+) versus medium/small organisations (<250) produces a highly statistically significant difference between the groups at p=0.003. This suggests that there is a threshold in terms of size over which internal pressures become more pronounced.

Table 8.8 describes the distribution of the respondents in relation to size and sector, and indicates the arithmetic mean for each sector. This table suggests that the predominantly lower values for the service/retail / wholesale sector, which has 13 very large organisations, may have reduced the mean rank score for the 'very large' group. To a certain extent the slightly lower score for the public sector group, compared with the construction/transport/logistics group, may also have produce the subtle difference between the large and very large mean rank score (as the public sector are predominantly large).

Table 8.8: Comparison between sector, size and mean score for internal drivers

Sector type	Small/ medium	Large	Very large	Total	Internal Drivers (mean for sector)
Public	1	8	35	44	3.59
construction, utilities, transport/logistics	8	2	13	23	3.74
service & retail/wholesale	7	2	13	22	2.64
mixed service/ manufacturing	8	5	3	16	3.16
Manufacturing	21	13	10	44	3.33
Total	45	30	74	149	

One of the constructs within the internal driver measure is *pressure from employees* (discussed in section 8.3.1). Baylis *et al.* (1998a, 1998b) found that employees concerns were cited by 48% of large companies as an important stimulus driving environmental improvements compared with 38% of SMEs, suggesting that larger firms experience more internal pressure than smaller firms. Henriques and Sadorsky (1996) link the influence of size to the formulation of an environmental plan/policy, suggesting that larger firms are more visible and more likely to be called upon to act as industry leaders. In fact, Lamming and Hampson (1996) suggest that smaller firms lack the resources, information or expertise to address environmental issues. It could be argued that smaller firms do not recognise the importance of environmental issues and that this results in a lack of internal pressure from employees and managers to address them.

The sectoral distribution shows significant differences between groups at $p<0.01$, and mirrors the distribution found in chapter 7 for the societal drivers. The service/retail/wholesale group experience the least internal pressure, with transport/logistics, construction and utilities experiencing the most. The public sector experiences the second highest level of internal pressure, followed by manufacturing. The sectoral differences may also be linked to levels of potential environmental impact and risk, which also demonstrate significant differences in internal pressure (at $p<0.01$). The sectors that appear to experience the highest level of internal pressure are also those that are traditionally perceived to be 'dirtier' or highly polluting such as construction or utilities. Yet, the manufacturing group which are arguably perceived by many to be amongst the 'dirtier' industries has only the third highest level of internal drivers. This perhaps reflects the fact that the manufacturing sector in this sample is very mixed in terms of what it produces and the type of processes used. Thus, this sample may contain a large 'light' manufacturing component rather than manufacturers with a very high environmental impact (like the 'dirty' industries studied by Min and Galle 1997).

Banerjee *et al.* (2003) examined a group of US firms designated as moderate environmental impact or high environmental impact and found that top management commitment was significantly related to internal corporate values in both groups. However, the level of top management commitment was only significantly related to management practices in the high impact group. High impact organisations are also very 'visible' due to the inherent risks involved in their processes The public sector is arguably also highly visible due to its' closeness to the public and is very risk adverse, and this perhaps reflect the high intensity of internal pressure in this group.

Ghobadian *et al.* 2001 examined a cross sectoral sample of the top UK companies and found that across all sectors the main internal drivers of environmental management were the influence of senior management and the desire to present an acceptable public image (both of which are individual internal driver constructs examined in table 8.5). However, they found that the relative importance of senior management commitment was most pronounced in utilities, then petrochemical, services, manufacturing and finance, which is similar to the findings of Banerjee *et al.* (2003) as discussed above.

It is difficult to directly compare the influence of sectoral composition between previous studies and this one, as there are differences in the sectoral classifications used and he specific sectors addressed. However, it would appear that higher risk or more visible organisations experience greater levels of internal pressure, as a result of the pressure from employees to respond to public concerns over safety, or to present a positive environmental image when the organisation is very visible to a local community.

8.4 Examining Environmental Attitude

This section examines the findings related to environmental attitude in more depth, specifically the criteria used to develop the attitudinal score (section 8.4.1) and variability in environmental attitude related to organisational contingencies of the respondents (section 8.4.2). In addition, section 8.4.3 examines if there are significant differences between the types of organisations based on their attitudinal typology and the level of internal and external drivers they experience.

8.4.1 Examining the criteria used to develop the Environmental Attitude Scale

The development of a surrogate measure of the environmental culture of an organisation in order to capture the complex internal dynamics in organisations is discussed in section 8.2.2. Henriques and Sadorsky (1999) and Bowen *et al.* (2001b) adopt a similar approach of using multiple constructs to capture environmental 'attitude'. The four constructs used to develop the composite measure of environmental attitude were introduced in section 8.2.2, namely the *importance of managing environmental issues in the organisations, whether this importance will increase over the next five years, the role of environmental issues in purchasing and logistics* and *the status of the organisations' environmental policies*. A brief descriptive overview of the findings for each of these four constructs is presented in this section.

The majority of organisations believe that managing environmental issues (85.1% of cases) and ethical issues (75.7% of cases) are important or very important to their organisation (table 8.9). There is a slight observable difference between the importance placed on managing environmental and ethical issues, with environmental issues perceived to be slightly more important (mean =1.78) than ethical issues (mean=2.06), on a scale that ranges from very important (1) to not important at all (5).

Table 8.9: Importance of environmental and ethical Issues (n=149)

	How important do you think the management of environmental issues is to you organisation?	How important do you think the management of ethical issues such as fair trade and human rights is to your organisation?
Extremely important	43.2%	34.5%
Important	41.9%	42.2%
Of moderate importance	10.1%	10.1%
Of slight importance	3.4%	10.1%
Not at all	1.4%	4.1%

The findings discussed above can be compared with those of Murphy *et al.* (1995)[12], which examined the management of environmental issues amongst a sample of members of the US-based Council of Logistics. Murphy *et al.* (1995) found 60.2% of their respondents identified the management of environmental issues of high importance. In this study, the role of environmental issues are classified as important or extremely important by 85.1% of respondents, an increase of almost 25% and suggesting that the importance of managing environmental issues has increased in magnitude in the time period since the Murphy *et al.* (1995) data was reported.

Table 8.10: Extent to which environmental issues are considered in purchasing and logistics

Extent to which environmental issues are considered in purchasing and logistics decisions	Frequency	Valid Percent
Environmental issues are considered above other factors	1	0.7
Environmental issues are given equal consideration with other factors	49	33.1
Secondary consideration after other more important factors	73	49.3
not considered during purchasing or as part of logistics	19	12.8
Environmental issues are not considered by the organisation at all	6	4.1

[12] Based on the empirical study previously reported in Murphy *et al.* (1994) and used again in Murphy *et al.* (1995, 1996)

Although environmental issues are perceived to be important or very important to over 85.1% of organisations in this study, this is not reflected in the integration of environmental issues into purchasing and logistics. In fact, only one organisation considers environmental issues more important than other factors during purchasing and logistics decision-making (table 8.10).

Table 8.10 indicates that 33% of the respondents consider environmental issues as an **equal factor** during the decision making process in purchasing and logistics activities. However, 49% of the respondents either consider environmental issues as a secondary factor in purchasing and logistics (below other criteria such as price), and 12.8% do not consider them during purchasing or logistics or do not consider them at all (4%). Effectively this means that environmental issues are only given equal consideration with other decision making criteria in an organisation by one third of respondents. The remainder place less, or no, importance on environmental issues during decision making in purchasing or logistics.

These findings have implications for the success of green supply chain management as a way to cascade environmentalism through industry, using market mechanisms. If environmental issues are not stressed in the criteria given to suppliers then the impetus for an organisation's supplier to make changes in their own processes and products is lessened and erodes the validity of the argument that market mechanisms can be used to promote environmentally responsible behaviour.

None of the respondents believe the importance of environmental issues will decrease in the next five years. The majority (87.8%), believe that this importance will increase, with only 12.2% believing it will stay the same. In the Murphy *et al.* (1995) study, 82.2% of respondents believed the importance of environmental issues would increase compared with 87.8% amongst the respondents surveyed in this study (table 8.11).

Table 8.11: Whether the importance of environmental issues will change over next five years

	Frequency	Valid Percent
Increase	130	87.8
Stay the same	18	12.2
Decrease	0	0
Total	148	

Henriques and Sadorsky (1996) also specifically ask about whether the importance of environmental issues will increase over a five-year period in their study. Although their paper does not detail the distribution of these results, their Logit model of environmental determinants found that firms that believed that the importance of environmental issues would increase were more likely to have an environmental strategy in place to respond to this 'threat'.

During the initial stages of the integration of environmental issues into an organisation the development of an environmental policy is often the first step, and it is an integral part of the use of environmental management systems. Whilst the development of an environmental policy is also arguably an operational activity it has been classed as part of the measure used to develop the environmental attitude score, as it is most often the precursor to the management practices detailed in chapter 9.

The formality of the environmental policy is often an indication of the importance that environmental issues have in an organisation (Henriques and Sadorsky 1999) is the public 'face' of an organisation's environmental commitment (Holt and Anthony 2000). Informal environmental guidelines or policies are perhaps more symptomatic of an aspirational environmental attitude, and therefore this element is included as part of the environmental attitude measure.

Over 70% of the respondents in the sample have formal organisational environmental policies and guidelines (table 8.12)[13]. The findings in table 8.11 can be compared with those reported previously in table 8.10 on the importance placed on environmental issues in purchasing and logistics. A comparison of the two suggests that whilst 72.4% of the organisations have a formal *organisational* level environmental policy (table 8.12), however this policy is not filtered down into *functional* purchasing and logistics policies (table 8.10).

Table 8.12: Whether organisation has formal or informal environmental policies and guidelines

	Frequency	Percent %	Valid Percent
Formal environmental policy and guidelines	105	70.5	72.4
Primarily an informal or unwritten environmental policy and guidelines	20	13.4	13.8
No environmental policy or guidelines	20	13.4	13.8
Did not answer	4	2.7	

An examination of the extent of the *organisational* level environmental policy through archival research (from an annual or environmental report) would validate the level of 'commitment' to environmentalism made by the organisations by exploring whether explicit mention is made of adopting green purchasing criteria in this published policy. Unfortunately the anonymous nature of the data collected for this study prevents this comparison for every organisation in this study.

There is a discrepancy between the large number of formal organisational level environmental polices (72.4%) and lower levels of integration of environmental issues into purchasing and logistics decisions (with only 33% considering environmental issues as equal factors in purchasing and logistics). This discrepancy supports the decision to use additional measures of environmental 'culture' beyond that of just presence/absence

[13] The four organisations that did not respond are all public sector organisations (district council of medium size, and large public sector organisations in the university, healthcare and local authority sectors).

of a formal environmental policy, by developing a measure of environmental attitude from four constructs (of which the extent of the organisational level environmental policy is one).

8.4.2 Variability in Environmental Attitude according to Organisational Contingencies

When the environmental attitude scale variable is examined in relation to organisational contingencies, there are statistically significant differences ($p<0.01$) in the strength of environmental attitude of the respondents according to size, the level of potential environmental risk or the level of potential environmental impact (table 8.13).

Table 8.13: Significant differences between groups of organisations and strength of environmental attitude

Kruskal Wallis Tests	*Chi Squared*	*df*	*Asymp. Sig*
Sector	3.968	4	0.41
Size	12.42	2	**0.00**
Market Type	4.610	2	0.10
Supplier Dependency	5.44	2	0.07
Customer Dependency	3.885	2	0.14
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1404	5145	**0.00**
Possible Environmental Impact	1791	4794	**0.00**

When the mean rank scores for each of these statistically significant organisational contingencies are examined (table 8.14) the groups with the highest mean rank scores are those with the strongest environmental attitude. An examination of tables 8.13 and 8.14 suggests a number of trends:

- The large organisations (250+) have a stronger environmental attitude than small and medium organisations; and
- Organisations with higher levels of potential environmental risk or impact have stronger environmental attitudes.

Table 8.14: Mean ranks scores for significant demographic influences on environmental attitude

Demographic Characteristics	Groups	N	Mean rank
Size	Medium/small (<250)	44	54.83
	Large (250-999)	29	86.28
	Very large (1000+)	70	76.88
Potential environmental impact	Lower	77	62.26
	Higher	65	82.45
Potential Environmental Risk	Lower	86	59.83
	Higher	55	88.47

A similar examination of the internal drivers (section 8.3.2) also found statistically significant differences between groups based on *size*, *environmental impact* and *risk.* However, the internal drivers also showed significant differences based on *sector*, which is absent from the environmental attitude findings. This confirms that the environmental attitude variable is in fact measuring different aspect of the internal forces within organisations, compared to the internal drivers. This justifies the retention of both measures in the green supply chain pressure / response model

Larger organisations do appear to be more environmentally '*progressive'* with 80% of all *progressives* falling into the larger size classification (250+), compared with 20% classed as medium or small. Table 8.14 suggests that as the size of organisation increases the level of environmental 'culture' of the organisation strengthens. In many ways the progressive through to conservative attitudinal continuum is similar to the corporate environmental strategy continuums developed by authors such as Bowen *et al.* 2001a; Ghobadian *et al.* 1998; Roome 1992; Welford 1999. In all of these previous attitudinal typologies it is commonly accepted that smaller organisations are least likely to adopt a progressive, proactive or leading position and that those organisations over a certain size (normally identified as 250+ employees) will be operationally more active and have 'stronger' internal environmental cultures.

The arithmetic mean for the *possible environmental risk* posed by the organisation for the environmentally *progressives* group is 2.61 (standard deviation = 1.02), for the *moderates* group the mean is 2.10 (standard deviation = 0.88) and for the *conservatives* it is 1.88 (standard deviation = 0.850)[14]. This suggests that the *progressives* are the highest risk group (with the highest mean), the *conservatives* the lowest and the *moderates* in the middle between these two positions. Higher risk groups will inevitably have more formalised approaches to environmental issues due to the higher environmental liability risk they face. Low risk, low impact firms are therefore least likely to recognise the importance of environmental issues.

Although large, visible, high environmental impact/risk firms are more likely to be *progressive* in their environmental attitude this may not be through choice, but as a direct result of severe 'external' pressure influencing the importance placed on environmental issues by top management. Ghobadian *et al.* (2001) proposed that leadership was a mediating factor between external pressure and environmental strategies and that external pressure will affect the level of commitment to environmental issues and the overall environmental strategy. Therefore, the following section examines in more detail the possible relationship between the drivers of environmental management and the 'environmental attitude' of the organisation to see if particular patterns emerge.

8.4.3 Examining the Differences between Attitudinal Type and Drivers of Environmental Management

The environmental attitude typology developed in section 8.2.2. is explored in this section. The purpose of this is to present a comparison with the prior work of Murphy *et al.* (1996) and to explore in more detail the influence of different external and internal drivers on the environmental attitude of organisations.

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14 The range of values for possible environmental risk ranges from 1 (negligible) to 4 (high).

Firstly the 22 external and internal driver constructs are examined (detailed in full in appendix 13)[15], followed by the scale variables developed to measure the internal and external drivers (table 8.15). In this analysis environmental attitudinal type (moderates, conservatives and progressives) is used as the independent variable with the focus of the discussions on whether there are significant differences in external and internal drivers based on this environmental attitudinal typology.

Table 8.15: Significant differences between attitudinal groups and scale variables measuring the drivers in the green supply chain pressure/ response model (ANOVA with Scheffe post hoc tests)

Driver Scales	Classification of attitude		Mean Difference	Std. Error	Sig	95% CI Lower	Upper
Legislative	Conservative	Moderate	-0.61	0.21	0.02	-1.14	-0.09
	Moderate	Progressive	-0.51	0.16	0.01	-0.91	-0.10
	Progressive	Conservative	1.12	0.21	0.00	0.61	1.63
Supply chain	Conservative	Moderate	-1.00	0.22	0.00	-1.55	-0.45
	Moderate	Progressive	-0.46	0.17	0.03	-0.88	-0.04
	Progressive	Conservative	1.46	0.22	0.00	0.93	2.00
Societal	Moderate	Progressive	-0.65	0.15	0.00	-1.03	-0.27
	Progressive	Conservative	0.94	0.19	0.00	0.46	1.42
Competitive	Progressive	Conservative	0.99	0.26	0.00	0.34	1.64
Internal	Conservative	Moderate	-0.61	0.20	0.01	-1.11	-0.11
	Conservative	Progressive	-1.10	0.19	0.00	-1.59	-0.61
	Moderate	Progressive	-0.49	0.16	0.01	-0.88	-0.10

Of the original 22 constructs measuring the internal and external drivers of environmental management activities three show no significant differences between the attitudinal groups: *pressure from individual consumers; pressure from the insurance industry; and in order to match the actions of competitors* (detailed in full in appendix 13). The remaining 19 constructs all show significant differences between the attitudinal groups suggesting

15 When assessing statistically significant differences in a one way ANOVA Bryman and Cramer (2001) recommend the use of the Scheffe post-hoc test to identify what the significant differences are between the different groups. Bryman and Cramer argue that the Scheffe test is the most conservative in the sense that it is least likely to find significant differences between groups and make a Type I error. The decision to use a parametric test, as opposed to a non-parametric one when normality cannot be assumed is discussed in appendix 9.

intensity of the external and internal drivers differs between environmental attitudinal groups (see appendix 13). Of the nineteen statistically significant constructs measuring the drivers in the green supply chain model, the *progressives* are significantly different from *moderates* or *conservatives*, or both, in nineteen of these constructs. *Progressives* and *moderates* are statistically difference in 12 constructs, *progressives* and *conservatives* in 18 constructs and *moderates* and *conservatives* in 11 constructs. Seven constructs (*possible environmental legislation, influence of suppliers and customers, influence of pressure groups, role of CEO and culture of organisation*) all show significant differences between all three attitudinal groups.

Since appendix 13 presents a large amount of data that is difficult to manipulate, it is perhaps more pertinent to examine if there are differences between the scales developed to measure each group of drivers and environmental attitudinal typology (table 8.15).

In the Murphy *et al.* (1996) study statistical differences were observed between *progressives* and *conservatives* in terms of *government regulation, managing liabilities and societal factors.* Similar findings are found in the individual constructs (appendix 13) with UK and EU legislation showing statistically significant differences between *progressives* and *moderates.* The threat of *forthcoming* and *possible environmental legislation* is felt most strongly by the *progressive* group, followed by the *moderates* and has least impact on the *conservatives.* The *legislative* scale shows significant differences between all three attitudinal groups (table 8.15).

The individual construct of *public opinion/ societal expectation* is identified as significantly different in intensity between the progressives and *moderates* groups, and the *progressives* and *conservatives* groups [16], suggesting that the *progressive* group is more conscious of their role in fulfilling societal expectation, than either the *conservatives* or the

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[16] in appendix 13

moderates. The societal scale (table 8.15) identifies significant differences between all three attitudinal groups. The *supply chain* and *competitive* scale variables are statistically different between the *progressive* and *conservatives* but not the *moderates*, which suggests that these factors influence *progressives* the most and *conservatives* the least. The internal drivers are statistically different between all three attitudinal groups, suggesting that the *progressive* group experience the greatest internal driver pressure and the *conservative* experience the least, and the moderates are positioned between these two extremes.

In all cases, as with the Murphy *et al.* (1996) study, the *progressives* perception of the internal and external drivers is significantly different to that of the other attitudinal groups (table 8.15).

Of particular interest is the fact that the *progressives* and *conservatives* differ greatly in their perception of operational cost savings associated with environmental management. The *progressive* group appears to have made a connection between environmental management activities and business benefits, both tangible benefits such as reducing operational costs and the more intangible benefits such as image, morale of employees and pressure from stakeholders. The *conservative* group shows significant differences mostly with the *progressives* – not unexpected since they are at different ends of the spectrum of attitudes to environmental management.

8.5 Obstacles to Green Supply Chain Management

This section examines the two types of obstacles to green supply (supplier and internal) previously identified in section 8.2.3.

8.5.1 Descriptive Overview

Table 8.16 examines the intensity of supplier-orientated and internal obstacles organisations[17], with higher values reflecting the greater intensity of that particular group of obstacles.

Table 8.16: Obstacles to green supply chain management in respondent organisations

	N	Not at all (%)	to a small extent	To a moderate extent	to a great extent	to a very great extent	Mean	Std Dev.	Mean Rank Order[18]
Internal Obstacles									
Lack of financial benefit/ profit from operating a green supply chain	140	14.3	18.6	27.1	27.1	12.9	**3.1**	1.2	1
Lack of managerial commitment to green supply chain management	143	27.3	18.9	28.7	18.2	7.0	**2.6**	1.3	6
Company wide indifference	141	24.1	28.4	24.1	17.7	5.7	**2.5**	1.2	7
Lack of trained personnel to implement such schemes	142	16.9	23.2	28.2	25.4	6.3	**2.8**	1.2	3
Supplier Obstacles									
Uncertainty of the availability of appropriate environmentally 'friendly' resources from suppliers	143	14.0	32.9	31.5	16.8	4.9	**2.7**	1.1	4
Difficulty in assessing supplier's environmental and ethical performance in an efficient and cost effective manner	143	12.6	26.6	30.1	21.0	9.8	**2.9**	1.2	2
Suppliers lack environmental awareness of our needs	142	12.7	35.2	36.6	14.8	0.7	**2.6**	0.9	5

The obstacles perceived to be the greatest barrier to green supply chain management appear to be associated with *lack of financial benefit* (mean of 3.1 and ranked first in table 8.16) and the *difficulty in assessing suppliers' environmental performance* (ranked as 2nd most influential obstacle). *Lack of trained personnel* is also influential to a moderate extent (mean = 2.8) and linked to the difficulty in assessing a supplier's performance.

When table 8.16 is examined, only the first obstacle that of lack of financial

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17 The data was gathered on a ranked scale with 1 representing 'not at all' and 5 representing 'to a very great extent'.

18 Based on arithmetic mean values

remaining six constructs have means in the range 2.5-2.9, with standard deviations ranging from 0.9-1.3. Overall this suggests that all of these obstacles are influential to small/moderate extent.

Additional obstacles to green supply chain management added by respondents in the open section of the questionnaire included time and resources required to action an environmental policy, the EC directives, resource pressure on procurement, resources to manage supply chain, devolved procurement environment and the nature of the individual business.

Min and Galle (1997) in a study of obstacles to green purchasing amongst a sample of heavy producers of scrap materials found that obstacles associated with costs were the highest ranked obstacles, in a similar manner to table 8.16. However, in the Min and Galle study 'uneconomical' or high costs of green purchasing strategies were a 'serious' obstacle to their respondents. Whereas, table 8.16 indicates that lack of benefits from green supply is on average only a moderately important obstacle (mean =3.1). This difference in the emphasis placed upon costs perhaps reflects the targeted respondents in the Min and Galle (1997) study and this research. Min and Galle only targeted industries that produced lots of wastes, resulting in a greater emphasis by respondents on the high costs of uneconomical recycling and reuse as significant barriers in these industries. In comparison, the cross-sectoral sample in this research included low waste producers, such as the service industries, through to manufacturing. A study of environmental strategies in UK organisations by Ghobadian *et al.* (2001) also found that operating costs were most influential mediating factor in all their cross sectoral sample.

In table 8.16 only 19.2% of the respondents cited *lack of managerial commitment* as an obstacle to green supply to a great or very great extent and 23% cited *company wide indifference*. Similar constructs are used in the Murphy *et al.* (1995) study, where 8% of respondents cited *lack of top management support* as a potential obstacle to establishing environmental policies, and 12% cited company *wide managerial indifference.* In both cases there appears to be a general opinion amongst at least 75% of respondents that *company wide indifference* and *lack of managerial commitment* are less influential obstacles to green supply chain management. Yet, in the Min and Galle (1997) study contradictory findings were found, with *lack of managerial commitment* classed as a serious obstacle to green purchasing. This perhaps reflects again the sample selection of their 'dirtier' high waste producing industries where lack of commitment by managers to environmental issues might be perceived as a greater barrier by purchasing staff, than managers in less risk intensive industries.

8.5.2 The Influence of Organisational Contingencies as Modifying Influences on Supplier and Internal Obstacles

Tables 8.17 and 8.18 examine the internal and supplier obstacles to green supply chain management.

Table 8.17: Assessing differences between groups of organisations and level of internal obstacles to green supply

Kruskal Wallis Tests Internal Obstacles	*Chi Squared*	*df*	*Asymp. Sig*
Sector	3.042	4	0.55
Size	4.991	2	0.08
Market Type	6.724	2	0.04
Supplier Dependency	1.3161	2	0.50
Customer Dependency	1.282	2	0.53
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	2318.5	3914.5	0.79
Possible Environmental Impact	2318	5341	0.50

None of the organisational contingencies appear to significantly affect the intensity of these obstacles at $p<0.01$. These findings suggest that the level of internal and supplier obstacles are not moderated by these specific organisational contingencies.

Table 8.18: Assessing differences between groups of organisations and level of supplier obstacles to green supply

Kruskal Wallis Tests Supplier Obstacles	*Chi Squared*	*df*	*Asymp. Sig*
Sector	40.527	4	0.34
Size	5.241	2	0.07
Market Type	0.720	2	0.70
Supplier Dependency	5.349	2	0.07
Customer Dependency	0.289	2	0.87
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	2317.5	3970.5	0.75
Possible Environmental Impact	2296.5	5222.5	0.38

8.5.3 The Relationship between Environmental Attitude and Obstacles

There are, however, statistically significant differences between different environmental attitudinal groups and the composite measures of supplier-orientated and internal obstacles. An examination of the seven individual constructs, which make up the two scale variables for internal and supplier obstacles indicates that four constructs show statistically significant differences between the environmental attitudinal groups as detailed in table 8.19.

Table 8.19: Comparison of conservatives, moderates and progressives in terms of obstacles to green supply chain management

Obstacles to GSCM	*Environmental Attitude*		*Mean difference*	*Std Error*	*Sig.*
Lack of financial benefit from operating a green supply chain	Moderate	Conservative	-0.89	0.223	0.012
	Moderate	Progressive	-0.67	0.227	0.015
Lack of managerial commitment to green supply chain management	Progressive	Moderate	-0.58	0.216	0.030
	Progressive	Conservative	-1.37	0.276	0.000
	Moderate	Conservative	-0.79	0.283	0.023
Suppliers lack environmental awareness of our needs	Progressive	Conservatives	0.84	0.214	0.001
	Moderate	Conservatives	0.68	0.219	0.009
Company wide indifference	Progressive	Moderate	-0.51	0.204	0.049
	Progressive	Conservatives	-1.44	0.263	0.000
	Moderate	Conservatives	-0.93	0.27	0.003

Three are not statistically different between environmental attitudinal groups and these are:

- lack of trained personnel to implement green supply chain management;
- uncertainty of the viability of appropriate 'environmentally friendly' resources from suppliers; and
- Difficulty in assessing suppliers' environmental and ethical performance in an efficient and cost effective manner.

A number of trends are suggested by table 8.19:

- Managerial indifference is perceived to be a barrier to green supply to the greatest extent by the *conservative* group and the least by the *progressives*;
- *Conservatives* perceive a lack of financial benefits from green supply chain management to a greater extent than the progressive group; and
- *Progressives* experience more difficulty with suppliers lacking environmental awareness than the other attitudinal groups

In this study the construct measuring the lack *of managerial commitment* as an obstacle to green supply is statistically significant for all the groups, progressives/moderates at $p<0.03$ and moderates/conservatives at $p<0.05$. Even more striking is the significant differences between *conservatives* and *progressives* at $p<0.001$. *Conservatives* perceive managerial indifference as a greater constraint to green supply chain management than the *moderates*, and the *progressives* experience this obstacle the least

In the Murphy *et al.* (1996) study, there was a statistically significant difference in *progressives/ conservatives* and *moderates/ conservatives* for managerial indifference. This suggests that managerial commitment is a significant difference between the two groups at each end of the attitudinal spectrum. The mean value[19] for *lack of managerial commitment* for the *progressive* group is 2.13, *moderates* 2.71 and *conservatives* 3.5. This

[19] Questions relating to the obstacles to green supply were scored 1- not at all, 2- to a small extent, 3- to a moderate extent, 4 –to a great extent, 5 – to a very great extent. The arithmetic mean is used for comparative purposes here – the mean for this construct for each attitudinal group. This indicates the direction of the difference in that construct relative to each attitudinal group.

suggests that lack of managerial commitment is less influential in *progressive* organisations and most influential in the *conservatives*. A similar item (that of *company wide indifference*) also shows statistically significant differences between the attitudinal groups, again with striking differences between *progressives* (mean 2.08) *moderates* (mean 2.59) and *conservatives* (mean 3.52).

In the Murphy *et al*. (1996) study, *lack of perceived benefits* was not statistically different between attitudinal groups. However, it is arguably significant in the data reported here as the construct regarding *lack of financial benefit/profit from green supply chain management* shows significant differences between *progressives/ moderates*, and *progressive/ conservatives* (table 8.19). The mean value for the *progressive* group for this construct is 2.68, suggesting that lack of financial benefit is an obstacle to a small/moderate extent. The *moderate* group (mean 3.35) and *conservatives* (mean 3.57) identified this as an obstacle to a moderate/great extent. This suggests that the win-win scenario, associated with the financial benefits associated with green supply chain management initiatives is not perceived by the *conservatives,* and only partially by the *moderates*, but does seem to be apparent in the *progressive* group.

The final statistically significant obstacle to green supply chain management is that of *suppliers lacking awareness* of the organisations needs. For this construct the progressives have the highest mean (2.75) compared to *moderates* (2.60) and *conservatives* (1.91). This suggests that problems with suppliers' lack of environmental awareness are most influential in the *progressives* group.

If the scales developed to measure the internal and supplier obstacles are examined (table 8.20), highly significant differences are apparent between internal obstacles and attitudinal type ($p<0.00$) but not supplier obstacles ($p = 0.07$) and attitudinal type.

Table 8.20: Internal and supplier obstacles to green supply chain management and environmental attitudinal typology (Kruskal-Wallis)

	Classification of attitude	N	Mean Rank	Chi-Square	Asymp. Sig.
internal obstacles	Conservative	24	94.92	21.29	**0.00**
	Moderate	52	75.45		
	Progressive	61	53.30		
supplier obstacles	Conservative	23	53.24	5.21	0.07
	Moderate	52	75.73		
	Progressive	62	69.20		

Internal obstacles are experienced the most by *conservative* groups, and this perhaps relates to the lack of an internal environmental culture in this group and constraints associated with managerial indifference. Whereas, supplier obstacles are experienced the least by the *conservatives* possibly because do not consider green supply chain management outreach activities as important and have not found supplier's lack of environmental awareness a problem because they have not addressed environmental issues with their suppliers.

This situation is reversed amongst the *progressives*, where internal obstacles are less influential, perhaps due to their progressive internal environmental culture. Supplier obstacles are experienced to some extent by the *progressive* group, perhaps because they have begun to address environmental issues within their supply chain, and encountered difficulties with suppliers when doing so. However, it could be argued that because of their progressive attitude they are likely to have put mechanisms in place to educate suppliers and facilitate green supply chain management practices. In comparison, the *moderate* group experience the greatest difficulty with supplier associated obstacles, reflecting perhaps their transitory position with increasing use of supplier management, but lacking outreach activities to facilitate this process.

8.6 Summary of Significant Differences between Internal Factor and External Drivers in relation to Organisational Contingencies

Table 8.21 summarises the impact of moderating organisational contingencies upon the internal factors in the pressure/response green supply chain management model (discussed in sections 8.3.2, 8.4.2 and 8.5.2). Size, possible environmental risk and environmental impact appear to produce the most diversity in results. Sector also appears influential for the internal drivers. None of the organisational contingencies appear to modify the internal or supplier obstacles to green supply chain management at $p<0.01$. Market structure shows some diversity in mean rank scores for the internal driver scale but only at $p < 0.05$.

Table 8.21: Summary of statistically significant differences (Internal factors) according to demographic characteristics

✓a significant at $p < 0.01$ ✓b significant at $p < 0.05$

Organisational Characteristics	Environmental Attitude	Internal Drivers	Internal Obstacles	Supplier Obstacles
Sector		✓a		
Size	✓a	✓a		
Type of Market			✓a	
Supplier Dependency				
Customer Dependency				
Possible environmental Risk	✓a	✓a		
Possible environmental Impact	✓a	✓a		

8.7 Conclusions

This chapter develops scale variables to measure the internal factors within the green supply chain management pressure/response model comprising of the internal drivers, environmental attitude, internal obstacles and supplier obstacles. The internal drivers and environmental attitude variables do not measure the same concept and both are included in the testing of the model in chapter 10.

The level of internal driver pressure, and strength of environmental attitude, increases as organisations increase in size, and as the level of potential environmental impact and environmental risk increase. There are also some sectoral variations in the internal drivers but not in strength of environmental attitude.

An examination of ANOVA tests between the external/internal drivers and environmental attitudinal type (moderate, progressive, and conservatives) indicates some significant differences between attitudinal groups. This suggests that there are potential relationships between external drivers, internal drivers and environmental attitude that need to be examined in chapter 10 when testing the model.

Obstacles to green supply chain management can be separated into internal and supplier obstacles. Neither of these two obstacles scale variables is significantly moderated by organisational contingencies (at $p < 0.01$). However, the level of internal obstacles does show statistically significant difference between different attitudinal groups, with the *conservative* group experiencing the highest level of internal obstacles to adopting green supply chain management practice.

CHAPTER 9: GREEN SUPPLY CHAIN MANAGEMENT PRACTICES

9.1 Introduction

The previous two chapters examine the proposed external drivers and internal factors influencing green supply chain management practices in organisations. This chapter examines the type and extent of this activity in response to these antecedent elements. The specific relationships between external driver, internal factors and operational activity are examined in chapter 10.

This chapter:

- Details the transformation of management practices data into numerical scale variables suitable for advanced statistical analysis (section 9.2);
- Presents a descriptive overview of the individual green supply chain management practices amongst respondents (section 9.3);
- Examines the moderating effect of organisational contingencies upon the total amount of green supply chain management activity and category specific environmental activity (section 9.4); and
- Explores aspects of green supply chain management activity (section 9.5).

9.2 Developing New Variables to Measure Operational Green Supply Chain Management Practices.

There are 32 constructs in the research questionnaire examining specific types of green supply chain management practices, developed from the literature review in chapter 2 and the model in chapter 3. These are examined individually in section 9.3. However, in order to undertake advanced forms of statistical analysis it is necessary to transform these constructs into new scale variables (e.g. Carter and Carter 1998; Carter and Jennings 2002, 2004).

A summary of the data transformation process is presented in figure 9.1. The data is presented in the form of a percentage score for the total amount of green supply chain activity (section 9.2.1), a percentage score for each of the six categories of activity (section 9.2.2) and a classification of the type of management practices undertaken (section 9.2.3).

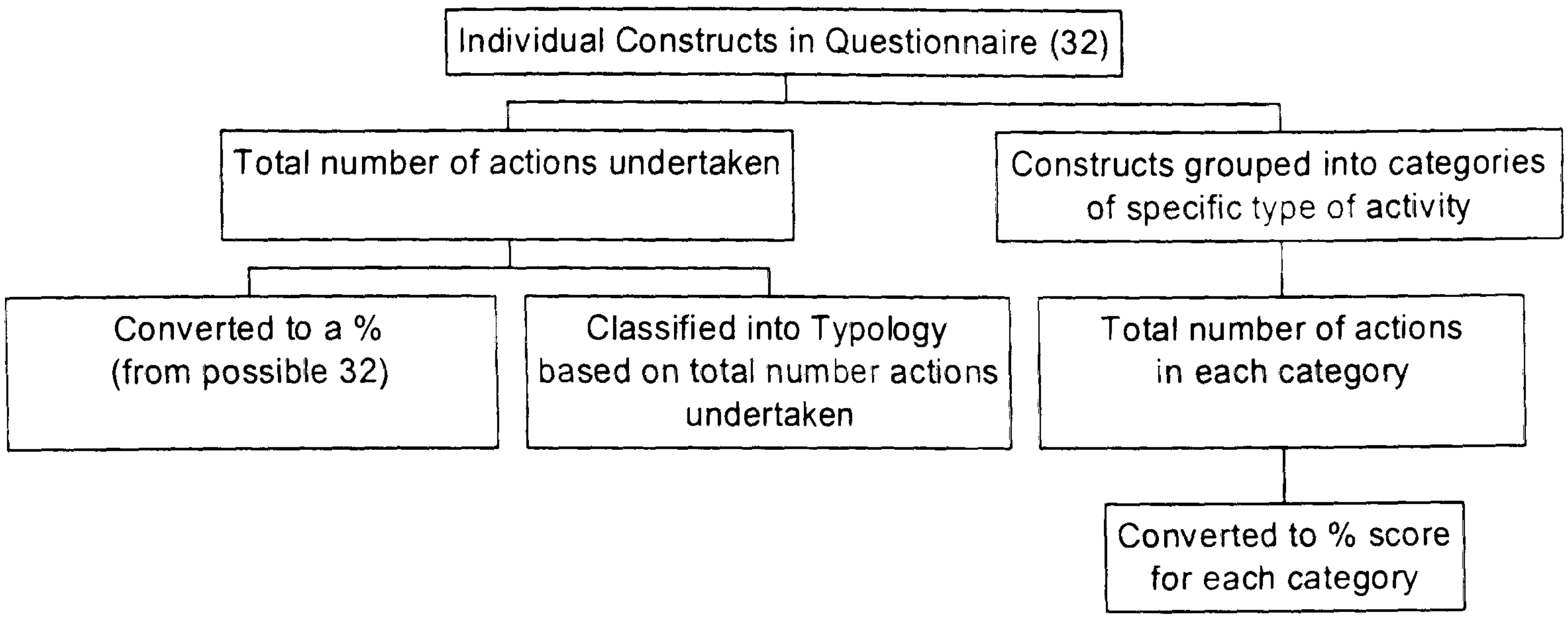

Figure 9.1: Summary of data transformation process for green supply chain management practices data

Few of the previous green supply chain management studies have statistically tested type and level of operational activity. Some studies develop an 'operational' measure from constructs to statistically test relationships in theoretical models (such the development of a measure of green purchasing by Carter and Carter 1998; Carter and Jennings 2002, 2004), or use a measure of an operational activity as a surrogate (such as aspects of environmental policy developments and attitudinal statements in Henriques and Sadorsky 1999). Other authors pre-select a potential survey sample to only include those that are operationally the most proactive, such as Rao (2002) who quantitatively examines 'leading edge' organisations in SE Asia and Walton *et al.* (1998) who qualitatively explores case examples in the US furniture industry.

In the main, previous studies present descriptive overviews of what specific operational activities occur. In this study the complexity of the type and level of green supply chain management activity is examined, and this requires more than the just the presence of a single action in an organisation to define an organisation's level of green supply chain operational activity. For instance the presence/absence of an environmental policy does not allow differences in green logistics activity compared with supplier education practices to be examined. In addition, the most influential prior studies typically adopt a limited sectoral focus, choosing a limited number of sectors (or sub-sectoral groups)[1]. Only the studies by Bowen *et al.* (2001a, b), Langerak *et al.* (1998), Rao (2002) and Zsidisin and Hendrick (1998) adopt a random cross-sectoral sample[2]. Min and Galle (1997) also examine a large number of sectors (11). The remainder of the previous influential studies limit their sample by targeting specific sectors. Therefore, the quantitative studies that examine aspects of green supply chain management operational practices are not fully comparable with this study, although the results for individual constructs can be compared to indicate general trends (as explored in section 9.3).

Respondents indicated whether each of the 32 management practices occur in their organisation[3]. As illustrated in figure 9.1 the transformation on the data captured by these constructs provides three measures of activity – a total measure, a measure for each of the types of activity and a classification based on an operational typology.

9.2.1 Total Green Supply Chain activity

This measure is produced using the summative score of total number of actual operational activities undertaken ('yes' responses only) from a possible total of 32, converted into a percentage.

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1 The full list is detailed in table 1.1

2 Of these only Rao (2002) examines operational activities across the whole of the supply chain (and then selects only a sample of ISO14001 accredited respondents). Bowen *et al.* (2001a,b) and Zsidisin and Hendrick (1998) focus upstream activities and Langerak *et al.* (1998) examines environmental marketing antecedents

3 Scored as 'yes', 'no', or 'intend to in next 12 months'. Bowen *et al.* (2001b) note that including 'intend to' as an possible choice decreases the influence of respondents giving socially desirable responses

GSCM Total Value = (<u>Total number of actions undertaken</u>) x 100

32

$$\text{GSCM Total Value} = \frac{\text{Total number of actions undertaken}}{32} \times 100$$

The new variable measuring the total green supply chain management activity is normally distributed, and illustrated in figures 9.2 (Kolmogorov-Smirnov test $p>0.2$)[4]. The mean value is 41.3% with a standard deviation of 18.32% (illustrated in figure 9.2).

This operational measure encapsulates the **totality** of green supply chain management practices in all the organisations surveyed.

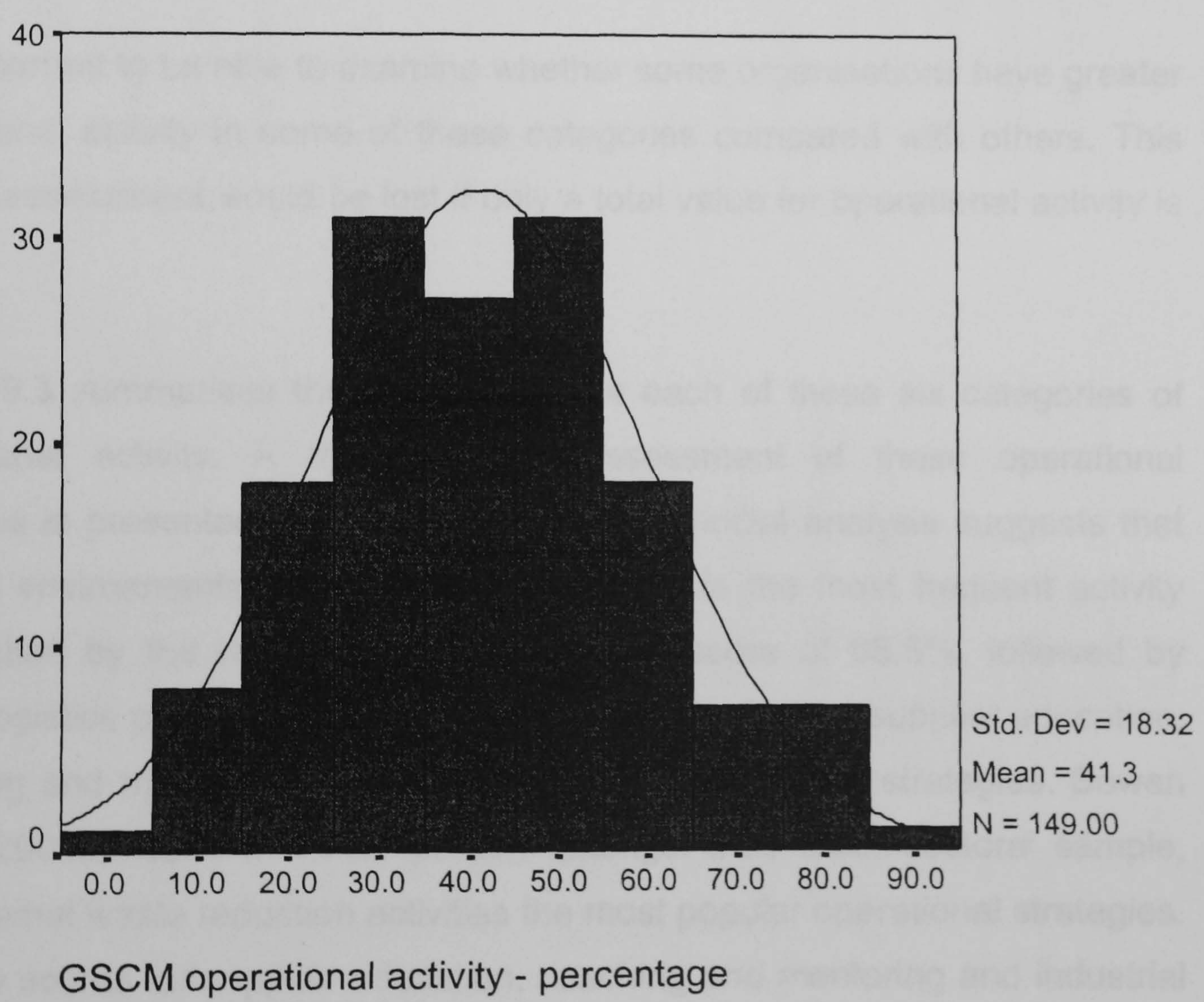

Figure 9.2: Histogram of % of green supply chain management total operational activity

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4 Whether a scale is normally distributed affects the types of statistical tests that can be used, as discussed in detail in Appendix 9.

9.2.2 Category Specific Green Supply Chain Operational Activity

In addition to a measure of **total** green supply chain management activity (section 9.2.2), there are six specific categories of activity defined in section 3.2

- Environmental Policy;
- Process design and redesign (environmental operations management);
- Supplier assessment, performance evaluation and selection strategies;
- Supplier education, mentoring, coaching and dissemination of best practice;
- Green Logistics programmes (including reverse logistics);and
- Development of industrial networks (waste exchange).

It is important to be able to examine whether some organisations have greater operational activity in some of these categories compared with others. This type of assessment would be lost if only a total value for operational activity is used[5].

Figure 9.3 summarises the distributions for each of these six categories of operational activity. A more detailed assessment of these operational practices is presented in section 9.3. However, initial analysis suggests that internal environmental operations management is the most frequent activity undertaken by the respondents with a mean score of 68.5%, followed by green logistics practices at 39.5%. Industrial networks and supplier education, coaching and mentoring are the least popular operational strategies. Bowen *et al.* (2001a) found a similar pattern amongst their cross-sectoral sample, with internal waste reduction activities the most popular operational strategies. The low scores for supplier education, coaching and mentoring and industrial networks practices suggests that 'outreach' activities only occur in a select group of organisations (discussed in section 9.3)

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[5] In each of the six groups of activities a total score (where 'does' is give +1, and 'intend to' or 'does not' do is given 0), can be calculated and divided by the total number of activities that can possibly be undertaken and multiplied by 100 to form a percentage.

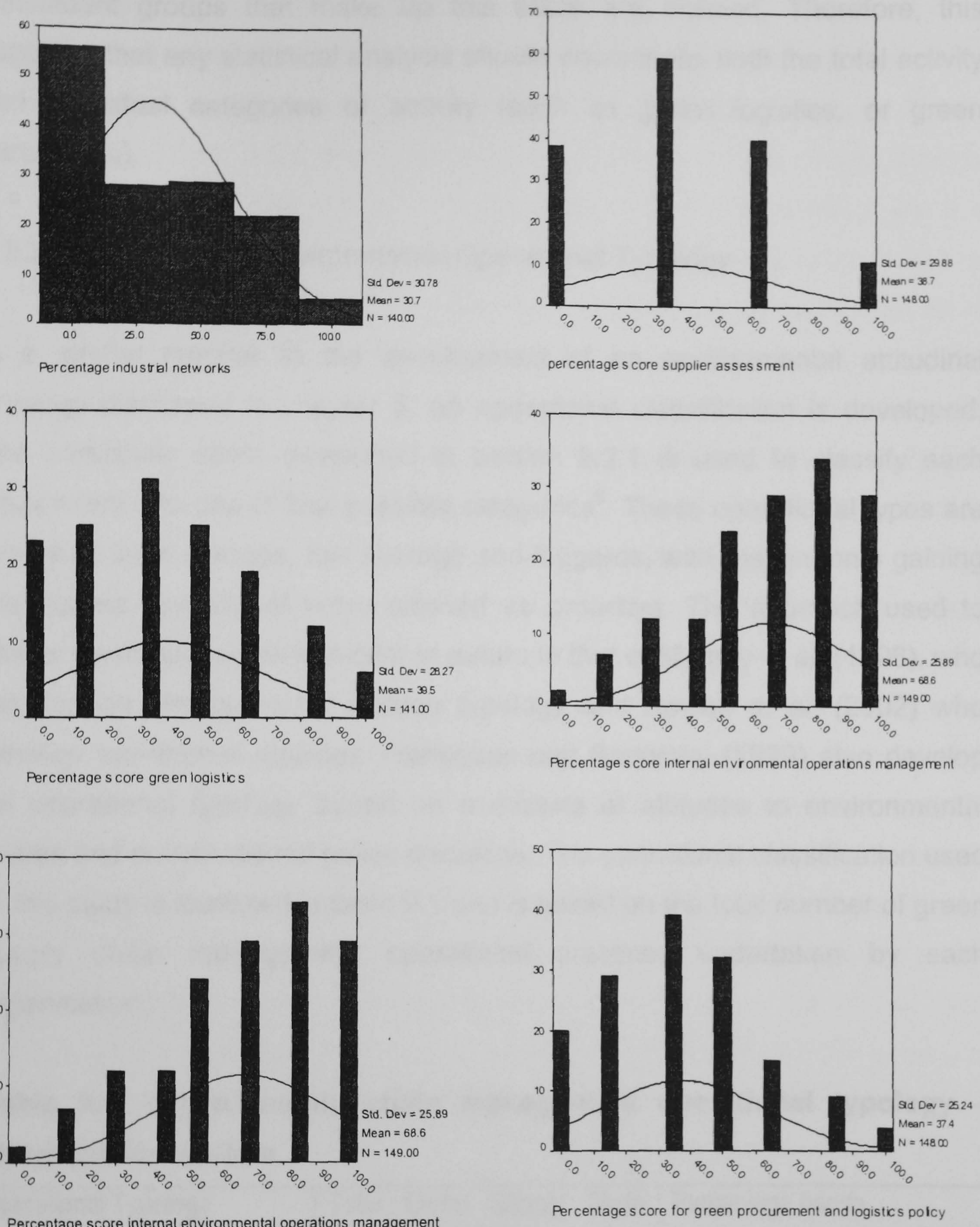

Figure 9.3: Distribution of percentage scores for each of the six categories of green supply chain management practices

Figure 9.3 illustrates the distribution of the percentage scores for each of the six categories of green supply chain management activities. None of the six percentage scales are normally distributed, with each one failing to gain a Kolmogorov-Smirnov value of $p>0.05$. This indicates that whilst the total green supply chain management activity score is normally distributed, the constituent groups that make up this score are skewed. Therefore, this suggests that any statistical analysis should encompass both the total activity and individual categories of activity (such as green logistics, or green purchasing).

9.2.3 Developing an Environmental Operational Typology

In a similar manner to the development of an environmental attitudinal typology discussed in chapter 8, an operational classification is developed. The composite score developed in section 9.2.1 is used to classify each respondent into one of four possible categories[6]. These operational types are proactive, high average, low average and laggards, with respondents gaining the highest operational score classed as proactive. The approach used to cluster the respondents is similar in nature to that of Murphy *et al.* (1996), who develop an environmental attitude typology and Bowen *et al.* (2002) who develop operational typology. Henriques and Sadorsky (1999) also develop an operational typology based on a mixture of attitudes to environmental issues and environmental policy decisions. The operational classification used in this study is identified in table 9.1 and is based on the total number of green supply chain management operational practices undertaken by each organisation.

Table 9.1: Green supply chain management operational typology – classification system

Operational Typology	Total Green Supply Chain Management Score	Percentage bands
Proactive	21 to 32	66-100 %
High average	14 – 20	44 - 65 %
Low average	7-13	20 - 43 %
Laggards	0 to 6	0 -19 %

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[6] Four categories of activity were selected as they represent the two extreme positions of very high and low activity, and allow the middle group to be divided into high and low average. In the judgement of the researcher the 'scores' allocated to each group represent the level of activity each group would undertaken. In addition, Bowen *et al.* (2001b) found four groups of green supply chain management practices so there are antecedent protocols for selecting this number of groups.

The cut off points between operational types (in table 9.1) are based on a judgement of what very inactive or very proactive firms might undertake in operational terms. Since no other studies use multiple constructs to classify operational activity there are no antecedent protocols for the criteria used to develop this operational score. In the Murphy *et al.* (1996) study there is a protocol to define attitude, as illustrated in chapter 8. This approach might be extended to cluster operational activity in a similar manner. In Bowen *et al.* (2001b) a typology of four operational types is developed from K-cluster means based on 12 operational constructs. Banerjee *et al.* (2003) tests the relationship between antecedents of environmental management and operational activity however, only a single measure of operational activity is used (related to the environmental plan/policy). In the Bowen *et al.* (2001b) study an operational measure of operational 'proactivity' is developed from five attitudinal and strategic constructs, that mixes both attitudes to environmental issues and operational practices, in a similar manner to Ghobadian *et al.* (2001). However, Gavaghan *et al.* (1998) in a general assessment of case studies of leading edge green supply chain management organisations also found subtle differences in operational practices amongst the most proactive organisations, stressing differences between a comprehensive (and arguably holistic) approach, or one focused on supplier efforts, or one related to exceeding specific industry requirements. The application of the approach described above resulted in 15 proactive organisation, 22 laggards, 60 high average organisations and 52 low average organisations (table 9.2).

Table 9.2: Frequency distribution of the operational typology classifications

N=149	Proactive	High average	Low average	Laggards
Frequency	15	60	52	22
% of sample	10.1	40.3	34.9	14.8

Using three different methods to segregate operational activity (total score, category specific and operational typology) allows subtle differences between organisations to be explored more fully. Using a total percentage score is the most simplistic approach. However, examination of the categories of operational activity presented previously (figure 9.3) indicates there are differences in the patterns of operational activity between groupings i.e. very few organisations are involved in industrial network activities and most are involved to at some extent in internal environmental management activities. This difference between various categories of operational activity is not apparent when just the measure of total green supply chain operational activity is used. The use of the operational typology allows the respondents to be defined in terms of total activity, but uses the approach of clustering them into four types. This again allows slightly different aspects of the green supply chain management operational activity to be explored.

9.3 Descriptive Overview of Green Supply Chain Management Operational Practices

Before exploring the total operational activity, category specific activity, and operational typology, it is important to examine the individual constructs from whence these measures were developed. Table 9.3 identifies the percentages of respondents that undertake each of the 32 actions used to assess green supply chain management activity. These constructs are grouped into the categories developed in chapter 3.

Table 9.3: The % of respondents undertaking a variety of environmental supply chain management practices

	Do	Do Not	Intend to in next 12 months	No response	Rank (based on mean)
Green Procurement and Logistics Policy					
We have a formal policy on green procurement/ purchasing	27.4	47.3	25.3		26
We have a formal policy on green logistics/transport	20.7	59.3	20.0		28
We have a green purchasing or logistics guidelines that recommend the environment is considered	48.2	36.9	14.9		12
We are bound by external purchasing directives (e.g. the EC Procurement Directive)	48.2	48.2	3.6		11
We consider ethical and human rights/ welfare issues informally in our purchasing decisions	64.7	25.7	9.6		7
We consider ethical and human rights/ welfare issues formally in our purchasing decisions	29.5	52.5	18.0		24

	Do	Do Not	Intend to in next 12 months	No response	Rank (based on mean)
Internal Environmental Management Practices					
Paper recycling in offices is standard practice	77.6	16.3	6.1		3
We recycle toner cartridges in the offices	85.8	8.8	4.1	1.4	1
Energy efficiency measures are adopted for lighting and heating	80.3	11.6	8.2		2
We actively manage the disposal of packaging wastes	71.4	18.4	9.5	0.7	5
We actively manage the disposal of all solid wastes in the organisation	72.7	14.7	6.3	6.3	4
We are required by law to control the disposal of some of our wastes	68.8	18.1		13.2	6
We have accredited to an EMS such as ISO14001 or EMAS	34.3	37.1	21.7	7.0	19
Logistics					
We consider environmental matters generally in our transport decisions	52.1	26.4	11.8	9.7	10
We have invested in vehicles that are designed to have reduced env. impacts	32.4	33.8	9.7	24.1	21
We plan the routes of our vehicles in order to reduce environmental impacts	26.6	37.8	6.3	29.4	27
We have energy efficiency systems in operation in our warehouses	32.2	26.6	4.2	37.1	22
Ask suppliers to use recyclable pallet systems when they deliver supplies to us	40.0	33.8	5.5	20.7	15
We expect our suppliers to take back their packaging or pallet systems they use to supply goods to us	46.9	31.7	10.3	11.0	13
Supplier Assessment and Evaluation					
We assess the environmental acceptability and performance of our suppliers informally in our assessment criteria	56.8	35.6	7.6		8
We assess the environmental acceptability and performance of our suppliers in a formal process	38.2	44.4	17.4		17
We set environmental criteria that suppliers must meet	27.9	46.9	25.2		25
Supplier Education, Mentoring and Coaching					
We communicate to our suppliers our environmental and/or ethical criteria for goods and services we buy	53.7	32.7	13.6		9
We run workshops/seminars to educate our suppliers	15.3	72.9	11.8		29
We educate our suppliers through written material	33.8	54.5	11.7		20
We (or someone on our behalf) goes into our suppliers' organisations to help them improve environmental performance	12.5	77.8	9.7		32
We have received environmental guidance from our own customers	39.6	60.4			16
We have been the recipient of educational workshops and visits by our customers to educate us on what environmental improvements can be made	15.1	83.5	1.4		30
Industrial Networks					
We are part of an industry specific partnership for good practice / lobbying	41.9	54.4	3.7		14
The organisation is part of an group that sources products and suppliers (such as the Ethical Trading Initiative)	13.4	79.9	6.7		31
The organisation is part of a general 'green' network that shares environmental or ethical good practice or information	31.4	62.8	5.8		23
The organisation is part of a supply chain initiative that is involved in active dialogue with suppliers and/or stakeholders	38.1	51.8	10.1		18

The following discussion draws upon the findings presented in table 9.3.

9.3.1.1 Green Purchasing and Logistics Policy

From a policy perspective the respondents appear to include environmental and ethical issues in purchasing and logistics activities primarily in an informal manner. Ethical issues are considered informally by over 64% (ranked 7th) of organisations, but formally by only 29.5% (ranked 24th)[7]. Less than one third of all respondents have either a formal environmental purchasing or logistics policy (ranked 26th and 28th).

However, 70.5% of the respondents stated that they have a formal environmental policy at the *organisational level* (table 9.4). If an organisation does not have a formal organisational level environmental policy, it is highly unlikely that a formal green purchasing or green logistics policy will exist. Future research needs to examine each of the formal environmental policies to see if there is an implicit mention of purchasing or logistic within them but the anonymous nature of the survey prevented this avenue of enquiry.

Table 9.4: Status of organisational level environmental policy

	Formal Environmental policy	Informal environmental policy	No environmental policy of guideline
Count	105	19	19
%	73.4	13.3	13.3

9.3.1.2 Internal Environmental Management Practices

The most frequent group of activities are associated with *internal environmental operational practices* (ranked 1-6th). This might be expected when many large and medium organisations begin a 'greening' process by 'cherry picking' these types of actions, where cost savings might be achieved.

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[7] A detailed assessment of supplier management practices is provided in Holt (2004). This paper discusses aspects of supplier management presented in table 9.4 and additional data collected on supplier management and assessment practices –see appendix 12

The remaining internal environmental management operational activity in table 9.3 (ranked 19th) is accreditation to an environmental management standard. This is the most 'advanced' internal activity and requires considerable commitment on the part of each organisation. Interesting this finding can also be compared to table 9.4, presented in section 9.3.1.1. Development of an environmental management system begins developing an environmental policy, with only the most advanced organisations accrediting their environmental management system to an official standard such as ISO14001. Therefore, whilst over 70% of organisation had an environmental policy, only 34% have taken the step of full development and accreditation of their environmental management system.

In Rao (2002) internal environmental operations management practices are the most frequent activities amongst a leading edge group of Asian firms, with over 94% of organisations using cleaner technology and optimizing processes to reduce environmental impacts, primarily through resource efficiency in waste, water and energy management[8]. Murphy *et al.* (1995) found that 74% of organisations reduce wastes through resource reduction, recycling and reuse. A key focus on recycling is also demonstrated by Florida (1996) where this was undertaken by approximately over 75% of respondents

9.3.1.3 Logistics

Over half of the respondents consider environmental issues generally in logistics (52.1%), but specific green logistics activities are much less frequent. For instance, planning of vehicle routes to reduce environmental impacts is only undertaken by 26.6% of the sample and using energy efficiency systems in warehouses adopted by 32.2%. The sectoral composition of the sample may influence these results. Although service industries might have vehicles routes they could plan and warehouse

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8 Rao (2002) uses a strongly agree-strongly disagree scale which may lead to socially desirable responses, as suggested by Bowen *et al.* 2001a, which may explain the very high

facilities they would use, transport issues are less influential in this sector than manufacturing.

Take back of packaging and pallet systems is adopted by 46.9% of organisations but requesting recyclable pallets/packaging systems is less frequent (40%). Again, sectoral composition may influence these results. Although service industries will receive delivered goods, the volume under consideration is much less than in manufacturing and processing industries. Thus, lower volumes may make consideration of suppliers' packaging/ logistics systems a less influential consideration

Murphy and Poist (2000) found 46.5% of their respondents (merchandising and manufacturing) had redesigned their logistics systems for greater environmental efficiency. A related study (Murphy *et al.* 1995) found 43.5% of respondents had redesigned their logistics systems. Both of these findings are similar to the findings in table 9.3 where 52.1% consider environmental issues generally in logistics. Interestingly, the sectoral composition in this study is much more diverse than that used by Murphy and Poist (2000) and Murphy *et al.* (1995), yet the affirmative percentage response is higher in this study. Green logistics practices are the most infrequent activities undertaken by 'leading edge' Asian firms (Rao 2002) with only 35% using waste exchange networks and 48% taking back packaging[9].

9.3.1.4 Supplier Assessment and Evaluation

Table 9.3 illustrates that 56.5% of the respondents assess the environmental acceptability of suppliers (ranked 8th). However, a distinct difference exists between the consideration of environmental issues in purchasing and logistics in a 'formal' or 'informal' manner. For instance suppliers are informally assessed by over 56% of organisations, but formally assessed by

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response rates for most variables

9 These figures may appear relatively high, but as discussed in 9.2.1.2 the study by Rao (2002) returned extremely high values. In many cases these are 80%+ as so figures in this region are relatively low

only 38%. Only 27.9% set specific environmental criteria that suppliers have to meet. Best practice guides such as BiE (1997) suggest that setting environmental criteria is a key element in developing green supply chains but this still appears to be an underutilised strategy.

Theyel (2001) examines US chemical firms identifying that 55% had environmental criteria set by their own customers. In this study 39% of organisations had received environmental guidance from their customers. Given that this study represents a cross-sectoral sample of organisations, rather than the highly visible and high risk chemical industries in the Theyel study, these finding suggests that many respondents from different sectoral groups maybe directly affected by supplier assessment practices as well as imposing requirements upon their own suppliers.

9.3.1.5 Supplier Education Coaching and Mentoring

The most infrequent operational activities involve outreach activities associated with supplier education, coaching and mentoring. In fact, only 15.3% have run supplier workshops (ranked 29th) and only 12.5% have visited suppliers to assist them to make improvements (ranked 32nd). Whilst the respondents did not visit their suppliers, they themselves had also not been the recipients of such outreach activities, with only 15.1% receiving visits from their customers to discuss environmental operational improvements (ranked 30th). The main form of outreach activity utilised is prescriptive, with 33.8% of respondents providing written material to educate their suppliers (ranked 20th).

As previously discussed in section 9.2.1.2, Rao (2002) found extremely high levels of operational activity amongst leading edge Asian companies, yet even in her study the supplier outreach activities were relatively infrequent, with 54% bringing suppliers together to share good practice and only 16% arranging financial support to help suppliers improve their environmental performance.

9.3.1.6 Industrial Networks

The constructs referring to *industrial networks* involve networks that organisations can join to lobby, share experience or gain guidance on environmental issues. 'Green' support networks are often promoted as a way to develop the environmental capabilities of organisations (see Holt *et al.* 2000 for a discussion of these). Yet, only 38.2% of respondents are involved in dialogue with suppliers and stakeholders. Slightly more organisations are part of industrial lobby groups (41.9%), which may reflect the close networking between public sector organisations in the sample. 'Green' support networks are used by only 31.4% of respondents and this suggests that reaching out to gain environmental advice is not a common strategy amongst the respondents. Interestingly a number of 'green' business networks have targeted SMEs in the belief that that this group need to be engaged through these kind of outreach activities. Given that the sample in this study is dominated by larger organisations, the lack of involvement in green business networks suggests two possibilities. Firstly, that they don't believe they need to be involved in such groups or secondly, that such groups should also focus on larger organisations.

Even less frequent is what might be termed as 'advanced' outreach activities where organisations join specific cross-sectoral networks associated with a topical issue (such as the Ethical Trading Initiative), as only 13.4% of respondents are involved in such networks. Networks like the ETI tend to be issue specific, like use of child labour or fair trade payments for farmers in developing countries and these may demonstrate significant polarisation into sectors. In this case, a cross-sectoral sample may not provide a sufficient number of sub-sectoral groups (like clothing manufacturers) to investigate the use of such issue specific networks.

None of the previous green supply chain management studies specifically examine the use of industrial networks, so direct comparison of the findings from this study is not possible.

9.3.1.7 *Examination of category specific operational activity*

Table 9.5 presents the summary statistics for each of the types of green supply chain management practices, based upon the summative values for the constructs within each grouping. The distribution of these mirror that of the individual constructs discussed in the preceding sections, with internal environmental management the most frequent operational activity and outreach activities such as industrial networks and supplier education, coaching and mentoring the most infrequent.

Table 9.5: Descriptive overview of types of category specific operational activity

Percentage score	N	Sum	Mean	Std. Deviation	Rank
Internal environmental operations	149	10214.2	68.55	25.9	1
Green logistics	141	5566.7	39.48	28.3	2
Supplier assessment	148	5733.3	38.74	299	3
Green procurement and logistics policy	148	5532.9	37.38	252	4
Industrial networks	140	4300.0	30.71	30.8	5
Supplier education coaching and mentoring	146	4032.9	27.62	26.0	6

Murphy and Poist (2000) found internal operational activities associated with waste reduction the most frequent operational activity amongst their respondents (ranging from 73.8-82.8%) which appears to support the predominance of internal operations management practices in table 9.5

9.3.1.8 *Summary comments*

The preceding discussion suggests a number of themes:

- Internal environmental management activities are the most common activities undertaken;
- Green supply chain management practices are predominantly reactive with outreach activities rarely undertaken (such as visiting suppliers or joining industrial networks); and
- Formal policies on green purchasing and logistics are more infrequent than the formal organisational level environmental policies.

9.4 The Moderating Influence of Organisational Contingencies on Green Supply Chain Management Practices

This section examines whether there are statistically significant differences in the type and level of green supply chain management activity, between different groups of organisations when clustered according to their organisational contingencies. To explore these possible differences this section examines: the total amount of green supply chain activity (section 9.4.1); category specific activity (section 9.4.2); and the operational typology (section 9.4.3).

9.4.1 Total Green Supply Chain Management Activity

Table 9.6 shows the statistically significant differences for overall green supply chain management activity in different groups of organisations, when they are clustered according to their organisational contingencies. There are statistically significant differences at p<0.01 in the level of total green supply chain operational activity, according to size, level of environmental impact or environmental risk and at p<0.05 in different sectoral groups and market type[10].

Table 9.6: Influence of organisational contingencies on total green supply chain management activity

Kruskal Wallis Tests	*Chi Squared*	*Df*	*Asymp. Sig*
Sector	9.651	4	0.047 *
Size	20.697	2	**0.000 ****
Market Type	6.432	2	0.040 *
Supplier Dependency	0.1382	2	0.933
Customer Dependency	3.187	2	0.203
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible Environmental Risk	1918.5	5923.5	**0.009****
Possible Environmental Impact	1900	5140	**0.002****

**** p<0.01** *p<0.05

10 See Appendix 11 for a worked example

Table 9.7 examines each of these statistically significant groupings. A high mean rank score indicates a high level of total green supply chain management activity.

Table 9.7: Mean rank scores for significant differences between demographic groups (Kruskal Wallis, Mann Whitney U)

Demographic	*Details*	*N*	*Mean rank*
Size	Medium/small (<250)	44	49.6
	Large (250-999)	30	82.9
	Very large (1000+)	73	85.0
Potential environmental impact	Lower	80	64.3
	Higher	68	86.6
Potential Environmental Risk	Lower	89	66.6
	Higher	58	85.4
Type of market	Business to business	66	60.4
	Business to consumer	21	68.8
	Mixed B2B and B2C	49	79.2
Sector type	Service or retail/wholesale	22	55.9
	Manufacturing	44	67.3
	Construction, utilities or Transport/logistics	23	81.2
	Mixture of service and manufacturing	16	82.5
	Public	44	86.2

A number of themes emerge from table 9.7:

- As size increases the level of total green supply chain management activity increases;
- Higher environmental impact and environmental risk organisations have a higher level of total green supply chain activity than lower risk/impact organisations; and
- Service or retail organisations have the least amount of green supply chain activity.

A pattern is emerging that links operational proactivity to size, with larger organisations undertaking more green supply chain management practices. Since the operational activities used in the questionnaire are 'graduated', ranging from simplistic actions (such as recycling toner cartridges) through to extremely advanced practices (such as accreditation of an EMS) the findings suggest that large organisations are not just increasing the total number of operational activities that they undertake, but the magnitude of activity. Bowen *et al.* (2001a) also note the pattern of a positive relationship between size and green supply chain management activity, suggesting that larger organisations are more visible and therefore more likely to be proactive. Other studies that also note the link between size and environmental proactivity include Aragón-Correa (1998) and Hutchinson and Chaston (1994).

Table 9.7 suggests that services, retail and wholesale sectors have the lowest total green supply chain management operational activity with the public sector having the highest levels of activity. Manufacturing has the second lowest level of total green supply chain management operational activity and this may be related to the 'type' of manufacturing industries in the sample, with 39 of the 57 manufacturing organisations designating themselves as low or negligible environmental risk. Without detailed SIC code analysis, which is not available, it is difficult to identify what specific products these organisations manufacture and the potential level of risk they pose.

The influence of sector upon total green supply chain management activity is statistically weak ($p<0.05$), with manufacturing and services amongst the lowest mean ranks scores, yet mixed service/manufacturing amongst the highest. Mann Whitney U tests of 'public' or 'not public' sector suggests that there is a significant increase in activity in the public sector, in comparison with the other sectoral groups ($p = 0.04$). A similar test for the manufacturing sector is not statistically significant ($p = 0.386$).

In comparison, Bowen *et al.* (2001a) did not find a link between sector and operational activity. However, in their study the level of analysis was on the clusters of organisations, which included mixed sectors. In a similar manner the operational groups in this study (laggards, low average, and high average, proactivity) are also composed of a mix of sectoral types. The implication of this is that sector will not be the only predictor of operational activity. The analysis of the respondent sample is not detailed enough to allow subtle differences in sectoral composition to be explored in this study (a finding also noted by Bowen *et al.* (2001a) in their cross-sectoral study).

Rather than sector it may be more pertinent to focus on the level of environmental risk and impact. The findings suggest that environmentally high risk/impact organisations are more operationally proactive, presumably to manage this risk. It may be that further research studies should move away from sectoral analysis towards a sampling framework based on potential levels of 'harm' posed by an organisation (as discussed in Holt and Viney 2001).

The findings of Bowen *et al.* (2001a) do contradict this link between environmental impact and proactivity. In their study, the cluster of most operationally proactive organisations were not considered high impact, whereas most of the high impact respondents were in a cluster that demonstrated less green supply chain management operational activity.

9.4.2 Category Specific Operational Activity

In this section the influence of organisational contingencies upon each of the categories of green supply chain management are examined (table 9.8). It might be that there are certain industry types that undertake specific operational activities at different levels of intensity for instance, more green logistics activities in the manufacturing sector when compared with services, as a result of more pertinent transport issues in manufacturing.

Very few previous studies specifically examine the impact of organisational contingencies such as sector and size on specific environmental operational practices. Where previous studies discuss comparable constructs, these are discussed in light of the findings in the following section. What is apparent from examination of these previous studies is how little the moderating effect of organisational/demographic characteristics has been examined in a systematic manner, in cross-sectoral research.

Examination of table 9.8 indicates that three of the six categories of green supply chain operational activity (*green procurement and logistics policy; supplier education; industrial networks*) are significantly different between groups based on organisational size at p<0.01 and two of the categories at p<0.05 (*internal environmental operations management* and *green logistics*).

Table 9.8: Significant differences based on organisational contingencies in each of the six categories of green supply chain management activity

Demographic Characteristics	**Supplier education coaching and mentoring %**			**Green procurement and logistics policy %**			**Internal Env. Operations Management %**		
Kruskal Wallis Tests	Chi-Square	df	Asymp. Sig.	Chi-Square	df	Asymp. Sig.	Chi-Square	df	Asymp. Sig.
Sector	5.9	4	.21	22.9	4	**.00**	6.4	4	.17
Market	.10	2	.91	11.5	2	**.00**	5.4	2	.07
Size	13.7	2	**.001**	23.1	2	**.00**	5.95	2	.05*
Supplier Dependency	.47	2	.79	2.8	5	.25	5.2	2	.07
Customer Dependency	.60	2	.74	5.6	2	.06	.76	2	.68
Mann Whitney U Tests	*Mann Whitney*	*Wilcoxon W*	*Asymp. Sig*	*Mann Whitney*	*Wilcoxon W*	*Asymp. Sig*	*Mann Whitney*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1968`	5796	.03*	2088	6093	.07	1930	5935	**.01**
Possible environmental Impact	2026	5107	.02*	1881	5121	**.00**	2209	5449	**.05***
p<0.01 highlighted in bold*				p<0.05 highlighted with *					
	Green Logistics %			**Supplier assessment %**			**Industrial networks %**		
	Chi-Square	df	Asymp . Sig.	Chi-Square	df	Asymp . Sig.	Chi-Square	df	Asymp . Sig.
Sector	8.2	4	.09	7.3	4	.12	1.8	4	**.00**
Market	4.5	2	.11	2.9	2	.23	4.1	2	.13
Size	7.1	2	.03*	5.1	2	.08	12.9	2	**.00**
Supplier Dependency	.120	2	.94	.37	2	.83	.91	2	.95
Customer Dependency	1.1	2	.57	.82	2	.66	5.9	2	.05
Mann Whitney U Tests	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*	*Mann Whitney U*	*Wilcoxon W*	*Asymp. Sig*
Possible environmental Risk	1954	5357	.10	2330	6335	.38	2057	5543	.30
Possible environmental Impact	2113	4814	.16	2431	5671	.31	1984	4759	.06

Two of the categories (*internal environmental operations* and *green procurement and logistics policy*) show differences in terms of possible environmental impact (at p<0.01). Sector appears to be a significant difference in two of the categories of operational activity (*green procurement logistics policy; industrial networks*). Market type and possible environmental risk appear to affect only one of the six categories (*green procurement and* *logistics policy* and *internal environmental management respectively*). Both supplier and customer dependency show no significant differences between groups.

Table 9.8 also indicates that the category of *supplier assessment* management practices shows no significant differences between groups based on any of the organisational contingencies examined. In comparison, the *green procurement and logistics policy* category is moderated by four organisational contingencies. Some of these significant moderating influences are discussed below.

9.4.2.1 Green Procurement and Logistics Policy

Murphy *et al.* (1995) suggest that larger firms have more formal environmental policies. This is supported by the findings here where size acts positively on levels of *green procurement and logistics policy*, as indicated by the mean rank scores in table 9.9, where the mean rank score increases as size increases.

Table 9.9: Influence of size of green procurement and logistic policy

size groupings	N	Mean Rank
small/medium	45	49.81
Large	30	76.22
very large	73	89.01

Murphy *et al.* (1995) also indicate a link between extent of formal environmental policies and sector with manufacturers more likely to demonstrate formal environmental policies than merchandisers. In this study, five sectoral groups are identified and manufacturing actually has the lowest mean rank score for green policies (at a similar level to services), with the public sector undertaking the greatest amount of green policy practices, thus contradicting the findings of Murphy *et al.* (1995), as illustrated in table 9.10. This finding perhaps relates to the bureaucratic nature of the public sector where formal policies may be more predominant. In addition, the sectoral classification of 'manufacturing' includes a range of manufacturing organisations that may have different levels of environmental impact and risk and may not automatically respond with formalised environmental policies.

Table 9.10: Influence of sector on green procurement and logistics policy

sector type	N	Mean Rank
public	44	97.85
construction, utilities, transport/logistics	22	79.52
service & retail/wholesale	22	61.98
mixed service/manufacturing	16	61.31
manufacturing	44	59.69

9.4.2.2 Internal Environmental Operations Management

Chapple *et al.* (2001) found that ISO14001 firms were typically larger than non-ISO 14001 firms. Baylis *et al.* (1998a) also found that relatively more large firms accredited to an EMS than small/medium firms. The internal environmental management operations category does not show statistically significant differences in relation to size in table 9.8 at $p<0.01$, but a weak association is present at $p<0.05$.

Accreditation to ISO14001 is one of the constructs incorporated into this internal environmental management scale. Table 9.11 suggests that small/medium organisations are less likely to accredit to an environmental management standard and supports the suggestion by Chapple *et al.* (2001) of the influence of size as a moderating factor

Table 9.11: Accreditation to an environmental management standard

Size	Yes	No
Small/Medium	11 (25.5%)	32
Large	11 (44%)	14
Very Large	27 (41.5%	38

Chapple *et al.* (2001) also found that industry type affected accreditation to an environmental management standard. Table 9.12 illustrates the sectoral distribution of accreditation to an EMS. The public sector is less likely to undertake EMS accreditation, along with the service, retail and wholesale sector (table 9.12). Whereas, high 'impact' sectors such as construction, utilities, transport and logistics have higher levels of accreditation.

Table 9.12: Relationship between sectoral group and accreditation to an environmental management standard

Sector	Yes	No
Public	9 (9.5%)	33
Construction, Utilities, Transport, Logistics	12 (57%)	9
Mixed service and manufacturing	6 (46%)	7
Manufacturing	18 (43.9%)	23
Service Retail and wholesale	4 (25%)	12

Zsidisin and Hendrick (1998) also examine 1SO14000 certification as part of their environmental management operational constructs. In their sample statistically significant differences were found between German, US and UK firms (not examined in this study) but their sample was moderately involved in EMS accreditation (producing a mean score of 4.09 based on a scale where 1 represented no involvement and 7 represented extensive involvement).

Overall the findings suggest that advanced environmental management practices such as accreditation to ISO14001 are affected by organisational contingencies such as size and previous studies suggest nationality of the firm may be influential.

9.4.2.3 Green Logistics

Green logistics practices demonstrate only one statistically significant difference between demographic groups (clustered according to size) and this relationship is only statistically significant at $p<0.05$. Autry *et al.* (2001) found that firm size negatively impacted reverse logistics performance. This contradicts the findings here where general green logistics activities (including reverse logistics) increase as size increases. However, the Autry *et al.* (2001) study only examined a specific sector that is particularly impacted by reverse logistics issues and regulation – the electronic industry. The same study also found no effect of industry type on reverse logistics (the sample was divided into two groups of electronics industries selling through catalogues). The much wider industry types used in this study also show no statistically significant differences between industrial groups at $p<0.05$

9.4.2.4 Supplier Assessment

Supplier assessment practices (as defined by the constructs detailed in table 9.3 and the composite measure in table 9.8) demonstrate no statistically significant differences when the sample is clustered according to size, sector, market, supplier dependency, customer dependency, potential environmental risk or environmental impact. This finding suggests that any differences in this operational measure displayed between organisations are controlled by some other influential factor(s).

9.4.2.5 Supplier Education, Coaching and Mentoring

Outreach activities, and the lack thereof, are discussed in section 9.3.1.5. Examination of table 9.8 suggests that size of the organisation positively affects this type of outreach activities. A weaker ($p<0.05$), positive, relationship also appears to exist between outreach activities and potential levels of environmental risk and impact. This suggests that as organisations become more visible (i.e. larger), or are visible through their potential environmental impact/risk, they make more of an effort to proactively reach out to their suppliers.

9.4.2.6 Industrial Networks

Only two organisational contingencies (sector and size) demonstrate statistically significant differences in levels of industrial network engagement. Table 9.13 indicates that as size increases so does involvement in external industrial networks. The public sector is significantly more advanced than any of the other sectors in industrial network activities.

Table 9.13: Mean rank scores for influence of sector and size on involvement in industrial networks

Sector and Size	N	Mean Rank
public	40	91.91
construction, utilities, transport/logistics	22	59.73
service & retail/wholesale	21	60.93
mixed service/manufacturing	14	57.21
manufacturing	43	65.09
Small/medium	43	53.02
large	29	70.66
Very large	68	81.49

9.4.3 Influence of Organisational Contingencies – Summary

Table 9.14 summarises all the statistically significant differences identified between groups of organisations when clustered according to their organisational contingencies, for each of the numerical scales variables developed in this chapter.

Table 9.14: Summary of moderating influence of organisational contingencies on individual variables

	Categories of Green Supply Chain Management Practices						
	Total Operational Activity	Green Procurement and Logistics Policy	Internal Environmental Operations Management	Supplier Assessment, Evaluation	Supplier Education Coaching and Mentoring	Green Logistics	Industrial Networks
Size Classification	✓a	✓a			✓a	✓b	✓a
Sector	✓b	✓a					✓a
Market	✓b	✓a					
Customer Dependency							
Supplier Dependency							
Possible Environmental Risk	✓a	✓a	✓a		✓b		
Possible Environmental Impact	✓a		✓b		✓b		

These are explored in terms of their impact on the green supply chain pressure/ response model in chapter 10.

9.5 Exploring Green Supply Chain Management Activity

As discussed in section 9.4.1 a pattern is emerging that links operational proactivity to size. This section examines the possible relationship between proactivity and progressiveness of environmental attitude. To explore any potential link between these, the operational typology developed in section 9.2.3 and environmental attitude typology developed in the previous chapter (section 8.2.2), is explored in this section. This also facilitates an exploration of some of the 32 individual green supply chain management operational constructs. A classification of operational type is derived using the total green supply chain management operational activity score for each case. The moderating influence of organisational contingencies upon total operational activity is examined in the previous section (section 9.4.1).

9.5.1 Operational Typology

Potential environmental risk and environmental impact are both identified in section 9.4.1 as moderating factors upon the level of total green supply chain management activity. Those organisations that designate themselves as of low environmental impact undertake less green supply chain management activities, and tend towards *laggard* operational status (as illustrated in table 9.15).

Table 9.15: Operational typology and possible environmental risk and impact of the organisations

Operational Type	Environmental Risk	*negligible*	*low*	*medium*	*high*
Laggards	Count (%)	8 (36.4)	8 (36.4)	6 (27.3)	0 (0)
Low average	Count (%)	12 (24.5)	22 (44.9)	9 (18.4)	6 (12.2)
High average	Count (%)	10 (17.9)	18 (32.1)	16 (28.6)	12 (21.4)
Proactive	Count (%)	2 (15.4)	5 (38.5)	4 (30.8)	2 (15.4)
Operational Type	**Environmental Impact**	*negligible*	*low*	*medium*	*high*
Laggards	Count (%)	5 (25)	10 (50)	4 (20)	1 (10)
Low average	Count (%)	10 (21.3)	18 (38.3)	14 (29.8)	5 (10.6)
High average	Count (%)	8 (14)	20 (35.1)	18 (31.6)	11 (19.3)
Proactive	Count (%)	1 (7.7)	2 (15.4)	4 (30.8)	6 (46.2)

Organisations that identify themselves as having a high level of environmental impact tend to be *high average* or *proactive* (73.9%) in terms of their level of green supply chain management activity. However, there are obviously other factors beyond that of just environmental impact which influence operational activity, as some high environmental impact organisations are very inactive. Conversely, some very low environmental impact organisations are very proactive. This suggests that the level of environmental impact might not be the dominant controlling factor, but that certain trends do appear (table 9.15) with high environmental impact organisations tending to be more proactive, but not exclusively so.

The pattern described above for potential environmental impact is mirrored by potential environmental risk, with significant differences between different groups of respondents when clustered according to their organisational contingencies. There is a trend towards increasing operational activity as environmental risk increases. In the highest environmental risk group there are no *laggards*; with 70% of this group classed as *high average* or *proactive* in the extent of their green supply chain management practices. In comparison, in the group with the lowest level of perceived environmental risk, 62.5% are *laggards* or *low average* performers. Yet, 37.6% of the lowest risk group are *proactive* or *high average*, suggesting that risk is not the only factor forcing increased green supply chain management activity (table 9.15).

It should be noted that designation of the potential level of environmental risk/impact of each organisation is a self selected criterion and any future examination of the role of environmental risk/impact should include questions that validate the level of environmental risk/impact identified by each organisation.

Size is a significant factor in the variability between respondents and shows a highly significant difference between different groups of organisations when clustered according to size. As size increases the amount of total green supply chain management activity tends to increase. The medium/small organisations are more likely to be *laggards* in their green supply chain management practices. There does appear to be a trend that larger organisations tend to be *proactive* or *high average* in terms of green supply chain operational practices. However, although 60% of the *proactive* organisations have over 1000 employees, only 12% of the total number of large organisations are *proactive*, suggesting that size is not always a precursor of proactivity.

The public sector has the largest number of *proactive* organisations, 57% of this sector are classed as proactive (20%) or as *high average* (37%). This suggests that public sector organisations are predominately more proactive than organisations from other sectors but that this is not universal. In the manufacturing sector approximately 41% of these organisations *are proactive or high* average. In the mixed manufacturing/service group 69% are *high average* but there are no *proactive* organisations.

In section 8.2.2 the formal status of the environmental policy is used as criteria in the development of the attitudinal typology. Therefore it is interesting to examine the relationship between the organisational environmental policy and green supply chain management operational typology (table 9.16). This relationship is statistically significant at p<0.000 using a nominal contingency co-efficient test.

Table 9.16: Relationship between formality of organisational level environmental policy and operational typology

		We have a formal environmental policy and guidelines	Primarily an informal or unwritten environmental policy & guidelines	we have no specific environmental policy or guidelines
Laggards	Count (%)	6 (27.3)	4 (18.2)	12 (54.5)
Low average	Count (%)	32 (64)	11 (22)	7 (14)
High average	Count (%)	54 (91.5)	4 (6.8)	1 (1.7)
Proactive	Count (%)	14 (100)	0	0
Total	Count (%)	106 (7.31)	19 (13.1)	20 (13.7)

All the *proactive* organisations in table 9.16 have formal environmental policies. It is the low performing group that is the most interesting in this table.

Presence or absence of a formal environmental policy is one of the most frequent supplier assessment criteria used by purchasers seeking to add an environmental dimension to their supply chains[11]. Here, 40% of respondents who assess the environmental criteria of suppliers (n=90) state that an environmental policy is essential, with a further 56.7% stating that they would like suppliers to have an environmental policy. Since 27.3% of the *laggards* have a formal policy this suggests that customers will assess these particular organisations as environmental 'responsible' because they have an environmental policy. Yet these *laggards* undertake less than 7 of a possible 32 management practices associated with environmentally responsible behaviour. However, there is a clear pattern emerging in table 9.16 that on the whole those organisations without a formal environmental policy are less environmentally active.

9.5.2 Environmental Attitude Typology

An examination of the classification of environmental attitude versus operational typology shows a statistically significant relationship at $p<0.01$, using a chi-squared test (table 9.17)[12].

Table 9.17: The relationship between environmental attitude and environmental operational activity

Attitudinal Typology	*Environmental Operational Typology*	laggards	*low average*	*high average*	*proactive*
Conservative	Count (%)	14 (56)	10 (40)	1 (4)	0
Moderate	Count	5 (9.4)	25 (47.2)	21 (39.6)	2 (3.8)
Progressive	Count	2 (3.1)	14 (21.5)	37 (56.9)	12 (18.5)
Total	Count	21 (14.7)	49 (34.3)	59 (41.3)	14 (9.8)
	Chi-Square Tests	**Value**	**df**	**Asymp. Sig. (2-sided)**	
	Pearson Chi-Square	63.6	6	0.00	
	Likelihood Ratio	61.7	6	0.00	
	Linear-by-Linear Association	48.9	1	0.00	
	N of Valid Cases	143			

11 This is a frequent recommendation in 'best practice' green purchasing guides such as BiE 1993

12 However in the Chi-Squared test 16.7% of the cells have expected counts of less than 5, which weakens this statistical test.

Table 9.17 appears to confirm the findings of Bowen *et al.* (2001a:51) who suggest that high environmental commitment leads to a more proactive green supply chain management strategies. It appears that the more environmentally *progressive* organisations are more likely to be operationally *proactive* (table 9.12). In fact, 75.4% of the *progressive* groups are classed as operationally *proactive* or *high average*. The relationship between environmental attitude and green supply chain management activity is clearest in the *conservative* group, where 96% of the conservatives are classed as *laggards* or *low average*.

The chi-squared test in table 9.17 has a number of cells with less than 5 responses, which weakens the validity of this test. Therefore a Kruskal-Wallis test between the percentage scale variable developed to measure total green supply chain management activity (section 9.2.1), grouped by attitudinal type is used to assess the influence of environmental attitude on operational activity. There is a statistically significant difference between the attitudinal groups at $p<0.000$. A correlation between the environmental attitude scale variable and total green supply chain management activity scale is positively correlated, with a Spearman's rho correlation coefficient of $r = 0.532$, significant at $p<0.01$. This suggests that green supply chain management activity may be related to environmental attitude and this is explored further in the next chapter, when testing the green supply chain management pressure/ response model.

It is also important that some of the 32 individual operational activities used to develop the total green supply chain management scale variable are examined to see if any particular patterns or trends emerge. Of the constructs originally presented in table 9.3, seven constructs show no significant differences between any of the environmental attitudinal groups (see Appendix 13). These are:

- We are bound by external purchasing directives (e.g. the EC Procurement Directive or Franchise agreements) *(mostly affects public organisations);*
- We recycle toner cartridges in the offices *(undertaken by 87% of*

organisations);

- ♦ We are required by law to control the disposal of some of our wastes (e.g. medical waste) – *(79.2% of organisations responded yes to this question.);*
- ♦ We have energy efficient systems in our warehouses *(the large number of public and service organisations who probably don't have warehouses may influence this response);*
- ♦ We expect suppliers to take back their packaging and pallet systems *(11% none response, 46.9% stated yes);*
- ♦ We plan the routes of our vehicles in order to reduce environmental impacts *(29% did not respond to this question);* and
- ♦ We ask suppliers to use recyclable pallet systems when they deliver to us *(20.7% none response).*

These seven non-significant constructs are either activities that seem to have gained universal acceptance (recycling toner cartridges and being required by law to control disposal of wastes) or activities in the green logistic category where a number of respondents did not answer[13].

In the remaining 25 green supply chain management practices there are clear differences for most between all three attitudinal groups. A high rank score means that that group does not undertake this action and a low score means that they predominantly do[14]. Those that state more aspirational targets of 'intent' occupy the middle position. There is convergence in rank score between the *progressives* and *moderates* in four activities, indicating that there is little difference between these groups in the following constructs:

- Adoption of energy efficiency measures;
- Recycling toner cartridges;
- Bound by external purchasing agreements; and
- Active management of the disposal of all solid wastes.

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[13] The green logistics actions could be applicable to all sectors. Therefore in the case of 'non response' a score of zero was awarded when calculating total operational activity.
[14] Scored yes= 1, intend to = 2, no=3

The highest mean ranks scores amongst the *progressives* (over 100) are for *communicating environmental criteria to suppliers* and having *environmental criteria that supplier should meet*. These are the least frequent actions amongst the progressives.

All the remaining actions show clear distinctions between the *progressive* (most frequently undertake these actions), *conservatives* (undertake these actions the least) and *moderates* (occupying the middle position where they tends to be more aspirational), as detailed in full in appendix 13.

Murphy *et al.* (1996) identified a number of green logistics activities that might be undertaken by all organisations in their sample, and that differentiation between *progressives, moderates* and *conservatives* occurred in the 'less' common criteria. Yet, some of the actions undertaken by over 70% of the entire group of respondents in this study still illustrate significant differences between *progressives* and *conservatives* (such as *managing disposal of packaging wastes*). Fifteen of the actions identified previously in table 9.3 are undertaken by less than 40% of respondents – but still demonstrate statistically significant differences between the attitudinal groups (such as the industrial network constructs).

Therefore, the arguments by Murphy *et al.* (1996) that differentiation occurs in the 'less frequent' activities does hold true in some instances, however the complexity of green supply chain management means that this might be quite a simplistic interpretation. *Progressives* undertake all the actions in table 9.4 more frequently than the other two groups (except in the instances of mean ranks convergence). Therefore stating that the groups could be differentiated based on 'less common' actions is too simplistic a generalisation in this study.

The Murphy *et al.* (1996) study found that the *progressives* were more proactive and this is certainly confirmed by a positive correlation ($p<0.01$) between the sum of environmental actions and the sum of the environmental attitudinal criteria. Thus, suggesting that the most *progressive* are the most *proactive*. The *progressives* gain the lowest mean score in all but one of the green supply chain activities (appendix 13) suggesting that this group proactively undertakes these activities, in comparison to the other two attitudinal groups. The *conservatives* consistently gained the highest mean score, suggesting again that these activities were less likely to be undertaken by this group. The *moderate* group tended to undertake some but not all of these actions.

Arguably, it could be suggested that 'green supply chain management' comprises of all of the individual actions previously detailed in table 9.3, since every action was undertaken by at least 12.5% of the respondents, but none of the 32 items are undertaken by 100% of respondents. Therefore green supply chain management appears to be 'translated' differently by every organisation. The use of the terminology '*progressive, moderate* and *conservative*' suggests that green supply chain activities can be identified to have certain 'thresholds' that are associated with environmental attitudinal groupings.

Further research should examine in more depth why each group undertakes certain actions and why some do not, to see if there is a pattern that reflects how green supply chain management practices differ between groups.

When examining the six categories of green supply chain operational activity, only one category (industrial networks) does not show a significant difference between the attitudinal groups at $p<0.05$ (table 9.18). The remaining five categories of operational activity all show highly significant differences between the groups. Inspection of the mean rank scores shows that *progressives* are consistently the most active and the *conservatives* the least active (table 9.18).

Table 9.18: Assessment of differences between progressives, moderates and conservatives for types of green supply chain management practices

	Classification of attitude	N	Mean Rank	Chi-Square	df	Asymp. Sig.
Percentage Score for supplier education coaching and mentoring	Conservative	24	32.69	32.96	2	**0.000**
	Moderate	53	68.12			
	Progressive	63	86.90			
Percentage score for green procurement and logistics policy	Conservative	25	43.04	24.72	2	**0.000**
	Moderate	53	64.89			
	Progressive	64	88.09			
Percentage score internal environmental operations management	Conservative	25	39.48	23.92	2	**0.000**
	Moderate	53	69.97			
	Progressive	65	86.16			
Percentage score green logistics	Conservative	24	39.63	23.58	2	**0.000**
	Moderate	50	63.54			
	Progressive	62	83.68			
Percentage score supplier assessment	Conservative	25	35.42	33.57	2	**0.000**
	Moderate	53	68.32			
	Progressive	64	88.23			
Percentage industrial networks	Conservative	22	52.95	5.55	2	0.062
	Moderate	52	65.70			
	Progressive	60	74.39			

The influence of environmental attitude on the drivers of green supply chain management are discussed in chapter 8 and here in chapter 9 in terms of operational activity, in light of the findings of Murphy *et al.* (1996). However, it is difficult to 'pigeonhole' each attitudinal group into a specific series of actions exclusive to that group. It is obvious that *progressive* organisations are the most *proactive* and tend to undertake a wide range of green supply chain practices. *Progressives* are very aware of the cost opportunities of green supply chain management and their wider societal role in managing environmental issues (see appendix 13). *Progressives* are more likely to reach out into the supply chain to set environmental criteria for suppliers but also to help educate and mentor suppliers. *Progressives* tend to class themselves as higher risk organisations with more formalised mechanism for managing environmental issues through formal polices and procedures. However, the distribution of the *progressive* group shows little association with sector, and therefore more work is needed on why these organisations perceive themselves to be 'higher' risk than other groups.

The *conservative* group assess themselves as predominately of lower/ negligible risk and environmental impact, and tend not to have formal environmental policies and guidelines. This group tends not to request environmental information from suppliers and on the whole act as *laggards* in terms of green supply chain management activities. Yet, 38.1% of the *progressive* organisations are also classed as *laggards* or *low average* in terms of practical green supply chain management activities, so this is not the exclusive domain of the *conservatives.*

Moderates appear to be transitionary between the two positions of *progressive* and *moderate*. Moderates tend to be *low/high average* in terms of green supply chain management practices, though there are two *proactive moderate* organisations. The *moderates* use a mixture of formal and informal processes for managing environmental issues, but they do believe environmental issues are important.

9.6 Conclusions

This chapter presents a predominantly descriptive overview of the findings from this study on green supply chain management practices amongst the 149 respondents to the survey.

Direct comparison between this study and previous research is hindered by the lack of comparability between the sectoral sample used and the measures of operational activity employed. However, some trends do emerge:

- That some organisational contingencies do appear to affect the type and levels of green supply chain management activity, such as size, level of potential environmental risk and impact and to a limited extent sectoral composition;
- That internal environmental management operational activities are undertaken by the majority of respondents;
- But outreach activities are the least frequent and tend to be undertaken by only the most proactive organisations; and

- There appears to be an emerging link between the environmental attitude of an organisation and levels of environmental operational proactivity.

The next chapter examines the statistical relationships between the three elements of the green supply chain management pressure /response model described in chapters 7, 8 and 9, in order identify any statistically significant relationships in this model

CHAPTER 10: EXAMINING RELATIONSHIPS IN THE GREEN SUPPLY CHAIN MANAGEMENT PRESSURE/RESPONSE MODEL

10.1 Introduction

Chapters 7, 8 and 9 individually examine the three elements of the green supply chain pressure response model (the external drivers, internal factors, and green supply chain management practices). In this chapter specific relationships that may exist between these three elements are examined, in order to test the validity of the green supply chain management model developed in chapter 3.

Firstly, possible correlations are examined to identify significant bivariate relationships (section 10.2) between different variables. Then elaboration analysis is undertaken to assess the possible intervening effect of other variables upon these relationships (section 10.3). Further exploration of the pressure/ response model is provided by applying multiple regression techniques (section 10.4). The influence of organisational contingencies i.e. demographic characteristics is examined in section 10.5, using a number of multiple regression models, including the moderating influence of organisational contingencies. In order to confirm the validity of this final model the data is re-examined controlling for various organisational contingencies in section 10.6. The chapter concludes with a discussion of the relationships in the final green supply chain model (section 10.7).

10.2 Bivariate Relationships in the Model

This section examines the use of bivariate correlations for each of the measures used to capture the external drivers, internal factors and green supply chain management practices developed in chapters 7, 8 and 9. All of these correlations are presented in Appendix 14. A statistically significant relationship between any two of these variables suggest that one variable might be affecting the distribution of another and this is the first stage in testing the relationships in the green supply chain model

In samples of over 100 cases small correlations may be statistically significant and Pallent (2002) recommends that the focus of the correlation results should be directed towards the assessment of *shared variance* between variables. Pearson correlation values range from 1 to -1, with a value of r=0.5+ classed as a large correlation (Cohen 1988). The amount of shared variance (the amount that one variable explains the scores on the second variable scale) is calculated by squaring the Pearson correlation and converting to a percentage. Table 10.1 summarises the statistically significant correlations amongst the variables in the model and their associated R^2 values. Although there are a number of additional significant correlations (detailed in full in Appendix 14) these are not examined if the r-value is less than 0.4 (after Cohen 1988; Pallant 2002).

The 16 variables in this table produce 48 statistically significant correlations at $p<0.01$, with $r>0.4$. All of the correlations identified are positive, (except one) suggesting that as the pressure exerted by the variety of drivers increases, the level of green supply chain management responses also increases. The exception is the negative correlation between internal obstacles and environmental attitude, which suggests that as the strength of an organisation's internal environmental attitude increases, internal obstacles decrease in intensity. This finding suggests that a positive environmental attitude in an organisation is able to exceed the barriers formed by internal factors.

An examination of Table 10.1 produces some interesting findings:

- The composite measure of external drivers (ext sum) is highly correlated with all of the constituent categories of green supply chain management practices, explaining between 49-72.5% of variance between the two scales. This suggests that the external summary variable measures almost 50% of the variance in all specific management practices. As such it is valid to retain this as a simplistic measure of the intensity of external pressure;

- Internal drivers are also highly correlated with the summary of the external drivers, with 49% of variance explained by a correlation between these two measures. This suggests that the external drivers do act upon the internal drivers, but that this relationship is not fully explained by just the intensity of external pressure and that the internal drivers should remain in the model;
- The internal driver measure is also highly correlated with the societal scale (49% of variance explained), legislation (36%) and to a lesser extent competitive (16%).This finding again suggests that the internal driver scale is related to the external pressures, but that none of these correlated variables explain the total variance in the level of internal drivers;
- The environmental attitude variable is related to the internal drivers (26% of variance explained) and external drivers (sum ext = 34.8%), but the constituent external drivers only explain between 17.6 -27% of the variance). This again suggests that environmental attitude is only partially explained by the external and internal drivers;
- A significant relationship exists between environmental attitude and total green supply chain management activity with 50% of the variance in the scales explained by this correlation, but that 50% remains unexplained by this relationship;
- However, in the individual bivariate correlations between the external driver, internal drivers, and environmental attitude, with total green supply chain management activity only 16-30.3% of the variance is explained. This suggests that the relationship between these and green supply chain management practices are affected by intervening variables. Therefore, multiple regression and elaboration analysis of the correlation coefficients is necessary;

Table 10.1: Summary table of significant Pearson correlations coefficients amongst variables and associated R^2 % values[1] (adapted from appendix 14).

Variables	Short Code	Leg	Sup Ch	Soc	Comp	Int Dr	Ext Sum	Env Att	Sup Obst	Inter Obst	SECM	GRLP	IEOM	GL	SA	IN	Total GSCM
Legislation	Leg	*		42.2		36	60.8	27				25	16		16	16	33.6
Supply Chain	Sup Ch		*	16.8	20.3		49	26							16		16
Societal	Soc	0.65	0.41	*	18.5	49	72.3	17.6				18.5					18.5
Competitive	Comp		0.45	0.43	*	16	49										
Internal drivers	Int Dr	0.60		0.70	0.40	*	49	26									21.2
summary external drivers	Ext sum	0.78	0.70	0.85	0.70	0.70	*	34.8				20.3	24		20.3		30.3
Environmental Attitude	Env Att	0.52	0.51	0.42		0.51	0.59	*		-17.6	38.4	38.4	38.4	16.8			50
Supplier Obstacles	Sup Obst								*	21.2							
Internal Obstacles	Inter Obst							-0.42	0.46	*							
Supplier Education Coaching and Mentoring	SECM							0.48			*	24		23	24		64
Green Procurement and Logistic Policy	GPLP	0.50		0.43			0.45	0.48			0.49	*			23		49
Internal Environmental Operations Management	IEOM	0.40						0.48					*				39.7
Green Logistics	GL							0.41			0.48			*			44.9
Supplier Assessment	SA	0.40	0.40				0.45	0.49			0.49	0.48			*		43.6
Industrial Networks	IN	0.40														*	29.2
Total operational activity	Total GSCM	0.58	0.40	0.43		0.46	0.55	0.64			0.80	0.70	0.63	0.67	0.66	0.54	*

* Correlation is significant at the 0.05 level (2-tailed)   Correlation is significant at the **0.01** level (2-tailed).

[1] The left hand side of the table indicates r values and significant correlations. The upper right hand side indicates the associated R^2 % values.

- Only legislative pressure explains the intensity of *specific* management practices (in four of the six categories) but this association is weak with explained variance of only 16-25%. Only two other significant correlations exist between an individual external driver and a specific group of management practices (with low R^2 values of 16-18.5%). Correspondingly, the total green supply chain management measure is predominantly used in the testing of the model as it explains more of the variance between the variables in the model;
- Supplier obstacles only produce a statistically significant relationship with internal obstacles (and this is low at 21.2% of variance explained). Therefore, this is excluded from later statistical analysis when testing relationships in the model. Internal obstacles also show only one low statistically significant relationship (with environmental attitude) and this is also excluded from later analysis; and
- Very high correlations between the individual drivers and total green supply chain management activity suggest that these individual drivers should remain within the statistical analysis when testing the model, rather than just using the summative external driver scale.

There is a high intercorrelation between the legislation and societal drivers (42.2% of variance explained). This can affect the use of multivariate statistical techniques when they are both retained in the analysis (Tabachnick and Fidell 2001). However, these associations are to be expected given the close link between societal factors and how these influence legislation and vice versa (as discussed in section 7.5.2). Both of these variables are very highly correlated with the summative external pressure variable (legislation 60.8% and societal 72.5%). Therefore, two potential models are explored (i) using the summative external scale to reduce the influence of intercorrelations –the simplistic model[2] ; and (ii) retaining all external pressure scales to examine the relative influence of each measure – the advanced model. The

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[2] De Vaus (2002:350) suggests that intercorrelated variables should be combined into a single measure using PCA and these component scores in statistical analysis. Therefore a single measure of external pressure (developed from PCA in chapter 7) can be used in later multiple regressions.

two amended models, in light of the above discussion are presented in figures 10.1 and 10.2 respectively.

Both the advanced and simplistic pressure/response models of green supply chain management do not presume which variable(s) may act as intervening/ moderating factors and suggest that both relationships, from external drivers acting 'through' internal factors (as the modifying variables upon operational activity), or external drivers directly impacting upon operational activities with no intervening influence of internal factors, may occur. Later analysis suggests which of these two scenarios appear dominant.

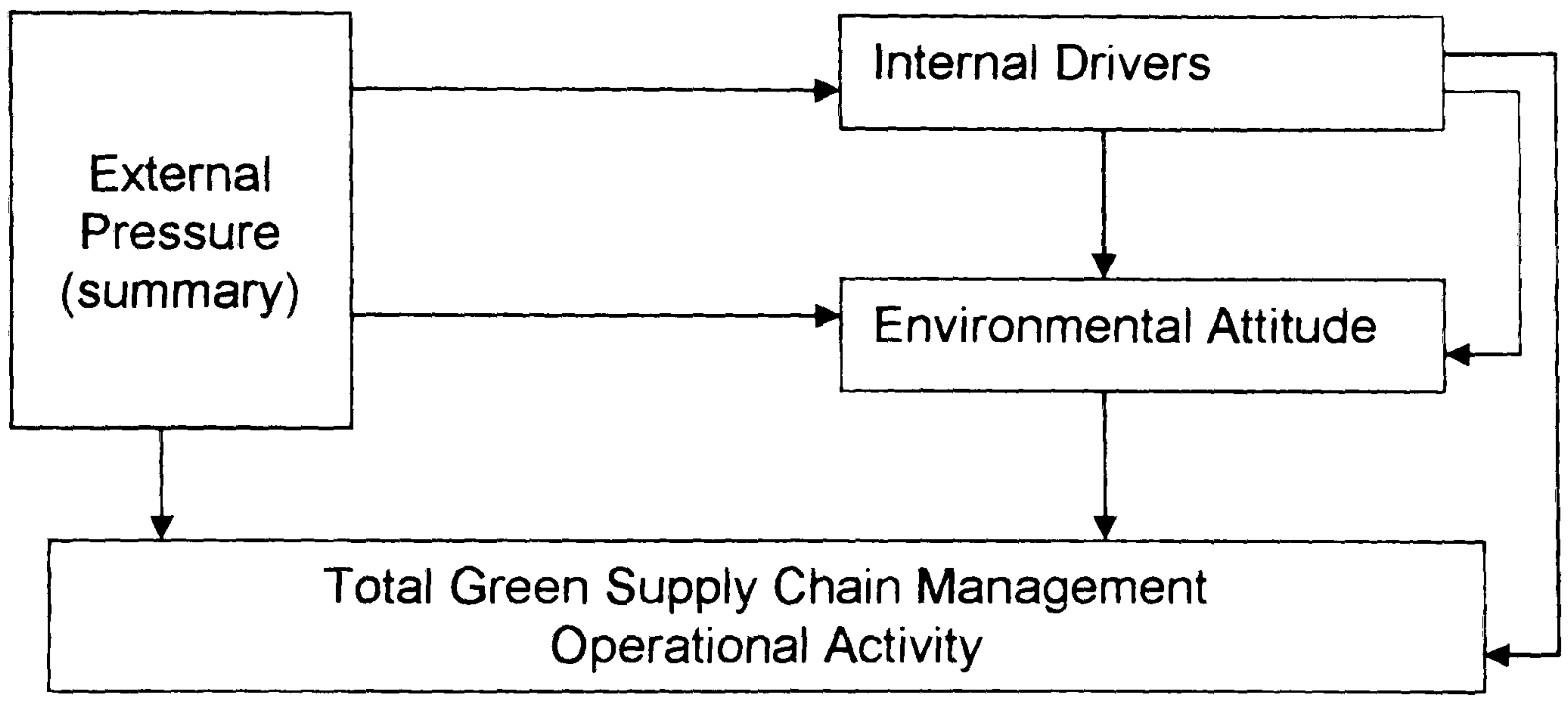

Figure 10.1: Simplistic pressure/response model of green supply chain management

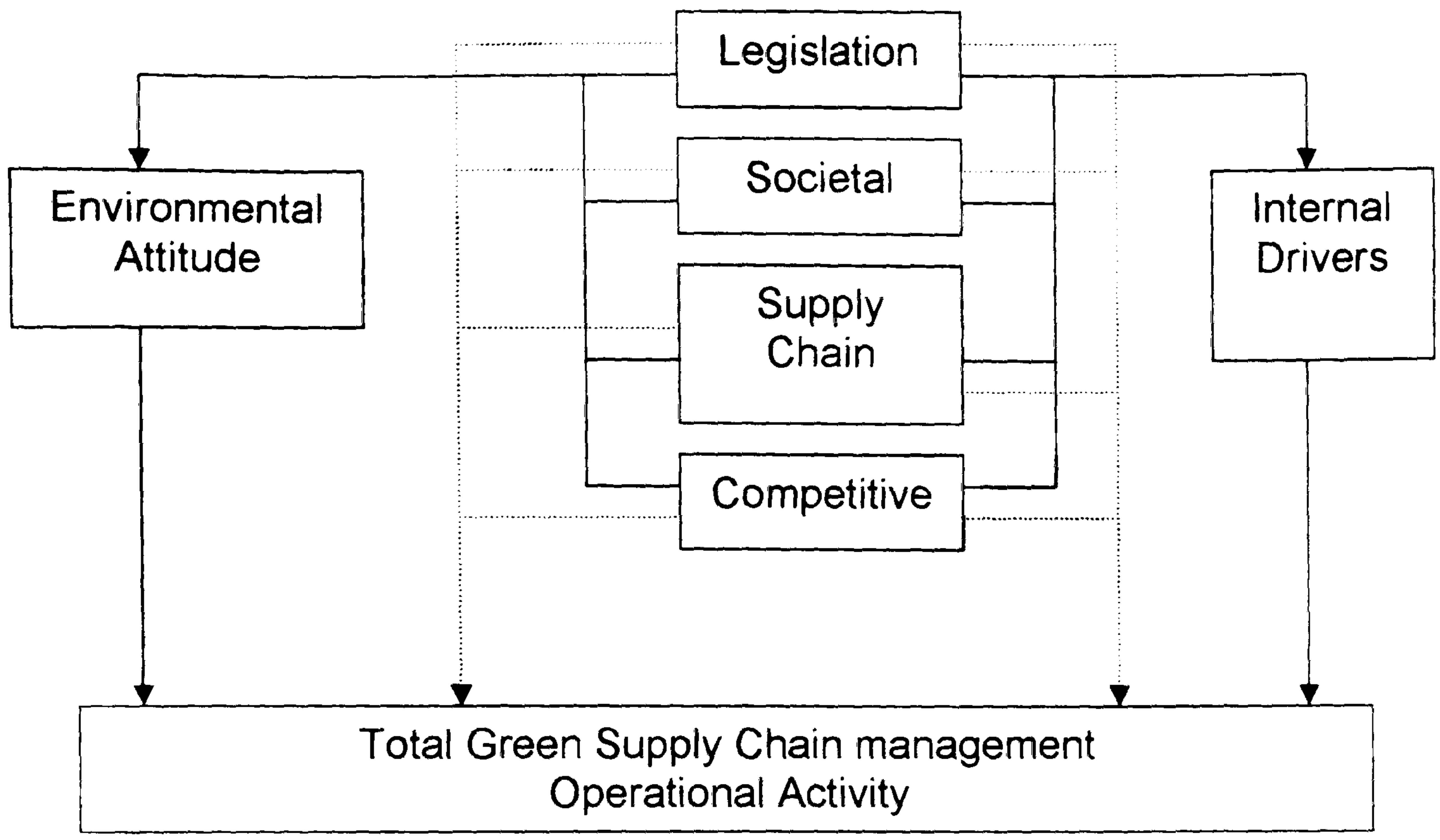

Figure 10.2: Advanced pressure/response model of green supply chain management

The findings from table 10.1 suggest that there are statistically significant relationships between the variables in the green supply chain pressure response model but these are not simplistic bivariate relationships. Thus, one or more variables may intervene in the relationship between two variables. De Vaus (2002) suggests that in this scenario elaboration analysis can be used. This chapter now examines the possible multivariate relationships that may exist in the green supply chain management model.

10.3 Elaboration Analysis

Correlation coefficients between the scale variables measuring external drivers and total green supply chain management activity indicate whether the external drivers act 'directly' upon operational responses. The presumption is made so far in this study that the external drivers act upon the internal factors, which in turn affect green supply chain management practices. This presumption may be a little simplistic, as it suggests that the internal factors are fully explained by the influence of the external variables, which is obviously not the case as discussed in the preceding section. The other alternative suggestion might be that external drivers act on latent variables that are not captured by the measures used in the research instrument to assess internal factors.

To assess whether external drivers act directly upon operational activity or act through the internal drivers or environmental attitude De Vaus (2002) suggests the use of partial correlations as a form of elaboration analysis as illustrated in Figure 10.3. In this statistical test the zero order correlation is produced between the independent variable (the external drivers in this case) and the dependent variable (operational activity). These are the correlations developed in the section 10.2 and summarized in table 10.1. In SPSS the third intervening variable is controlled for as part of a partial correlation. The zero order correlation and new partial correlation can be compared to see if the new variable affects the original relationship.[3] The relationship between the summary of external drivers and total green supply chain management activity is used as an illustrative example, with environmental attitude as the intervening variable (figure 10.3).

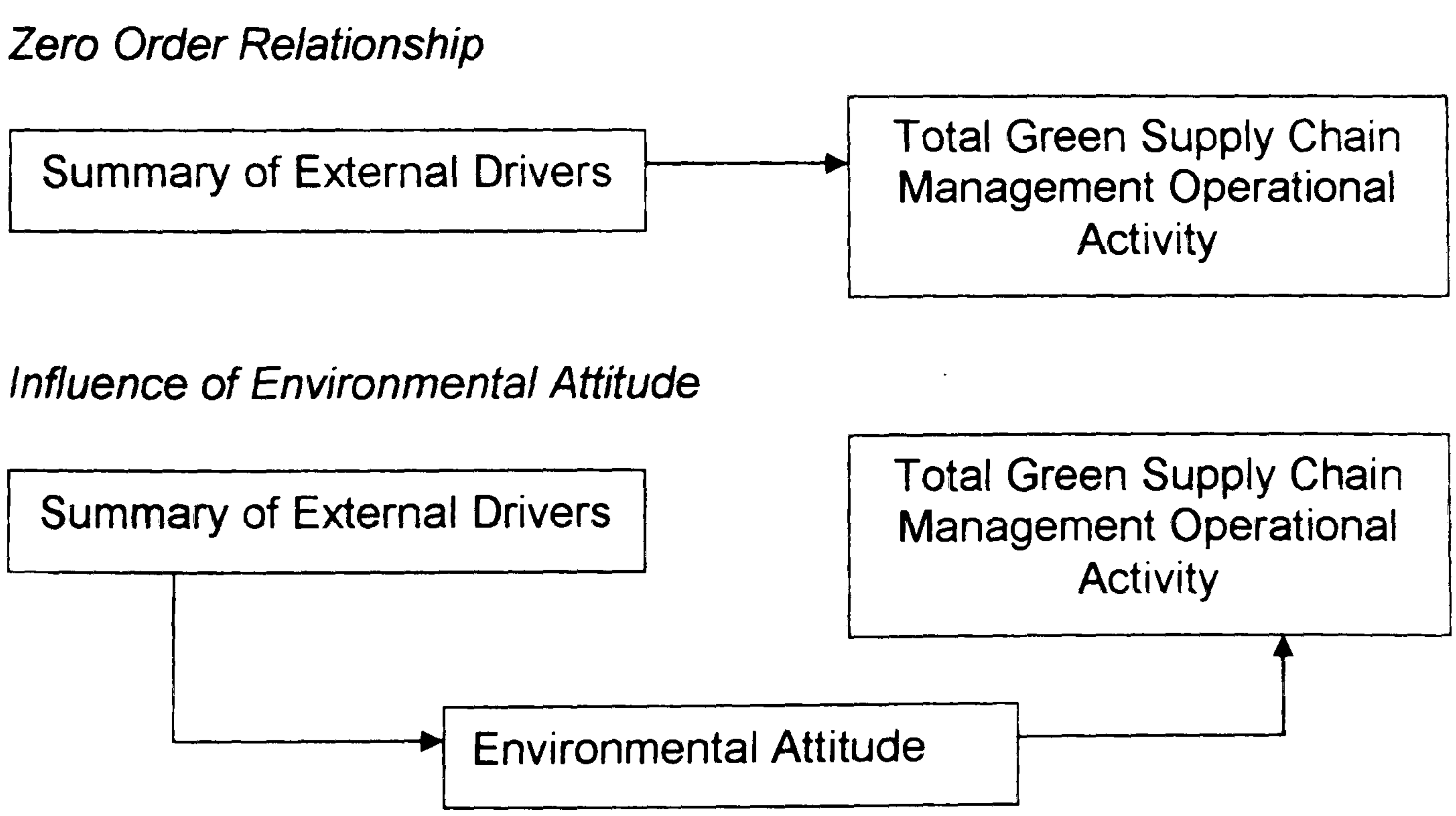

Figure 10.3: Zero order correlations and partial correlations

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3 See De Vaus (2002: 340) for a full explanation on how to interpret the difference between zero order and partial correlations

Table 10.2: Correlations between drivers (internal and external) and total operational activity controlling for environmental attitude

X variable (env. attitude controlled)	Zero Order		Partial		Implication[4]
	r	p	r	p	
Sum external	0.55	0.000	0.28	0.001	Partly spurious or indirect but direct relationship exists
Legislative	0.59	0.000	0.37	0.000	Partly spurious or indirect but direct relationship exists
Societal	0.44	0.000	0.25	0.004	Partly spurious or indirect but direct relationship exists
Supply Chain	0.40	0.000	0.11	0.218	Completely spurious or completely indirect
Competitive	0.22	0.008	0.03	0.809	Completely spurious or completely indirect
Internal Drivers	0.45	0.000	0.17	0.051	Completely spurious or completely indirect

Table 10.2 summarizes the findings for partial correlations for all the external drivers when environmental attitude is controlled. This indicates that environmental attitude does affect the relationship between the external drivers (summary measure), legislative and societal drivers. However, environmental attitude does not affect the relationship between competitive drivers, internal drivers and supply chain drivers and total green supply chain management activity.

An alternative model might be that environmental attitude (X variable) affects green supply chain operational activity (Y variable) as illustrated in figure 10.4. In this manner, environmental attitude determines operational activity. To investigate this possibility the partial correlations can be reversed and compared with table 10.2. The findings for this scenario are detailed in table 10.3.

[4] See Appendix 9 for full explanation

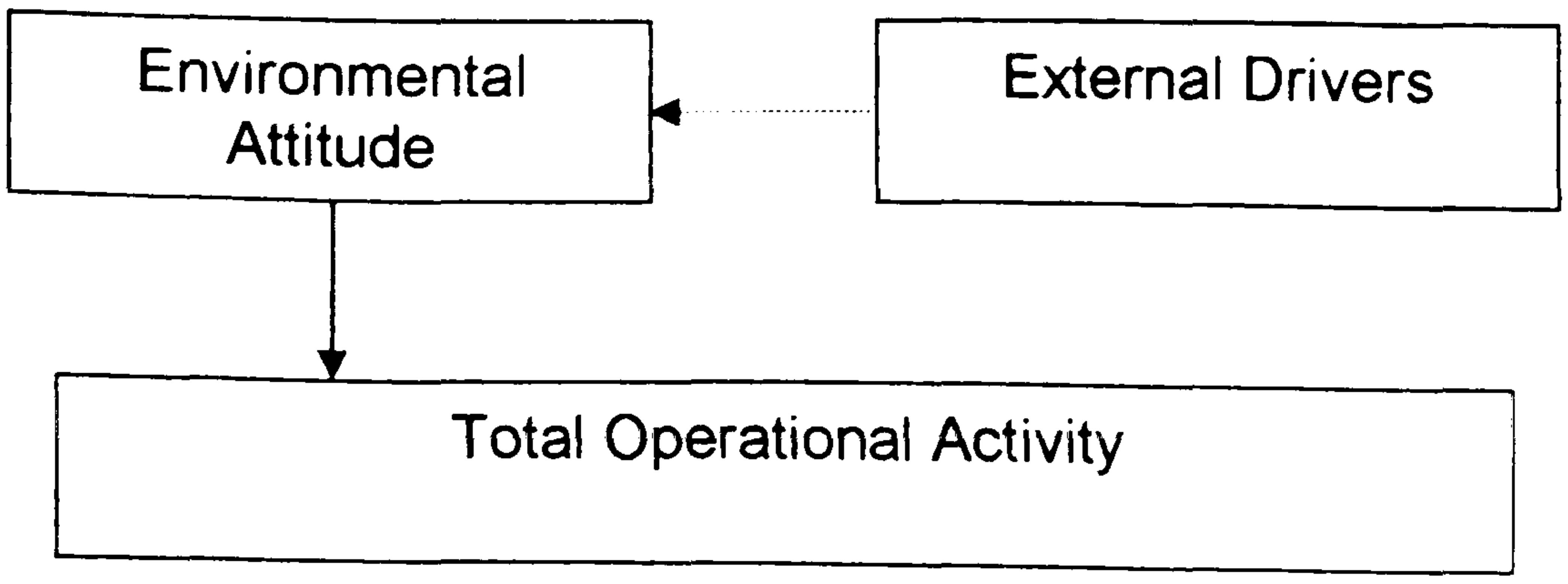

Figure 10.4: The relationship between environmental attitude and operational activity and the effect of drivers on environmental attitude

The results in table 10.3 suggest that the all of the external drivers except the competitive driver and the internal drivers, have some effect upon the relationship between environmental attitude and operational activity. However, when the correlations in table 10.3 are compared with 10.2 it is clear that the decrease in the Pearson correlation coefficient when environmental attitude is controlled is much greater compared with when the external drivers are controlled. The major implication of this is that it appears that the **external pressures do not determine the level of operational activity *through* environmental attitude.** In fact, **it is the environmental attitude that appears to determine the level of green supply chain management activity**, with environmental attitude indirectly affected to some extent by the external drivers.

Table 10.3: Influence of drivers on relationship between environmental attitude and operational activity when controlling for each of the drivers.

	Zero Order		Partial		
Controlled by	r	P	r	p	Implication
Internal Drivers	0.67	0.000	0.57	0.000	Partly spurious or indirect but direct relationship exists
Summary External	0.64	0.000	0.47	0.000	Partly spurious or indirect but direct relationship exists
Legislative	0.64	0.000	0.49	0.000	Partly spurious or indirect but direct relationship exists
Societal	0.64	0.000	0.56	0.000	Partly spurious or indirect but direct relationship exists
Supply Chain	0.64	0.000	0.55	0.000	Partly spurious or indirect but direct relationship exists
Competitive	0.64	0.000	0.61	0.000	Replication No impact

Earlier, (in section 8.2.2.1), the case was made for retaining both environmental attitude and internal drivers within the green supply chain model. Elaboration analysis of the relationship between the internal drivers and total green supply chain management re-examines the usefulness of the internal driver scale within the pressure response model of green supply chain management (table 10.4), when controlling for internal drivers.

Table 10.4: Relationship between external drivers and environmental attitude on total green supply chain management operational activity

X variable (controlling internal drivers)	Zero Order		Partial		Implication
	r	p	r	p	
External Summary	0.55	0.000	0.36	0.000	Partly spurious or indirect but direct relationship exists
Legislation	0.57	0.000	0.41	0.000	Partly spurious or indirect but direct relationship exists
Societal	0.42	0.000	0.17	0.000	Partly spurious or indirect but direct relationship exists
Competitive	0.25	0.004	0.08	0.333	Completely spurious or indirect
Supply Chain	0.42	0.000	0.29	0.001	Partly spurious or indirect but direct relationship exists
Environmental Attitude	0.67	0.000	0.57	0.000	Partly spurious or indirect but direct relationship exists

Table 10.4 indicates that the internal drivers act to some extent on all the possible relationships in the model, except competitive. Therefore, the relationship between environmental attitude and operational activity is affected partly by internal drivers. Section 8.2.2 discusses the relationship between environmental attitude and internal drivers and suggests that there is some overlap between these two variables in terms of their development from similar types of constructs. Table 10.4 confirms that the internal drivers do actually measure slightly different internal values, as evidenced by their partial direct influence upon the relationship between environmental attitude and green supply chain management activity. The internal drivers appear to exert some influence upon each of the external drivers (except the competitive drivers) and their bivariate relationship with green supply chain management activity.

The major implication of table 10.4 is **that the internal drivers and environmental attitude do measure different aspects of the internal factors** in the model and that both should be retained in the later analysis. **The competitive external driver does not affect any of the relationships in the model.** This finding confirms that there is not a direct link between competitive pressure and green supply chain management activity. It may be that the construct that measures competitive pressure is not detailed enough to detangle the influence of competitive pressure from the other external pressures when used on a cross-sectoral sample with different levels of competitive pressure (especially since there are a large number of non-profit organisations within the respondent sample such as the public sector).

10.4 Further analysis of relationships in the green supply chain management pressure/ response model

The elaboration analysis of the partial correlations in section 10.3 suggest that the dominant driver of green supply chain management activity may be related to environmental attitude, with a partial effect from the external drivers of legislation, supply chain and societal pressures. This section explores the relationship between environmental attitude and green supply chain management activity (section 10.4.1), before using multiple regression to test the primary predictors of operational activity (section 10.4.2).

10.4.1 Relating Environmental Attitude to Environmental Actions in Green Supply Chain Management

Previously in section 9.5.1 a cross-tabulation of green supply chain management operational typology (classification of operational response into four categories) and attitudinal typology (classification of attitude into three categories), identified an apparent relationship between attitude and action[5]. A chi-squared test for this cross-tabulation is significant at $p<0.000$[6]. Section

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[5] A more detailed examination of the possible relationships between the attitudinal types and different aspects of green supply chain management is examined in chapter 9 (section 9.5.2)

[6] However, there are a number of cells with less than the recommended frequency. Therefore

10.3 also confirms this relationship between environmental attitude and operational activity. Using the scales developed to measure environmental attitude and total green supply chain management operational activity, a scatter plot can be produced that examines this possible relationship (figure 10.5). A correlation between these two variables appear to suggest a significant positive relationship with a Pearson's r-value of 0.64, which is significant at $p<0.000$[7].

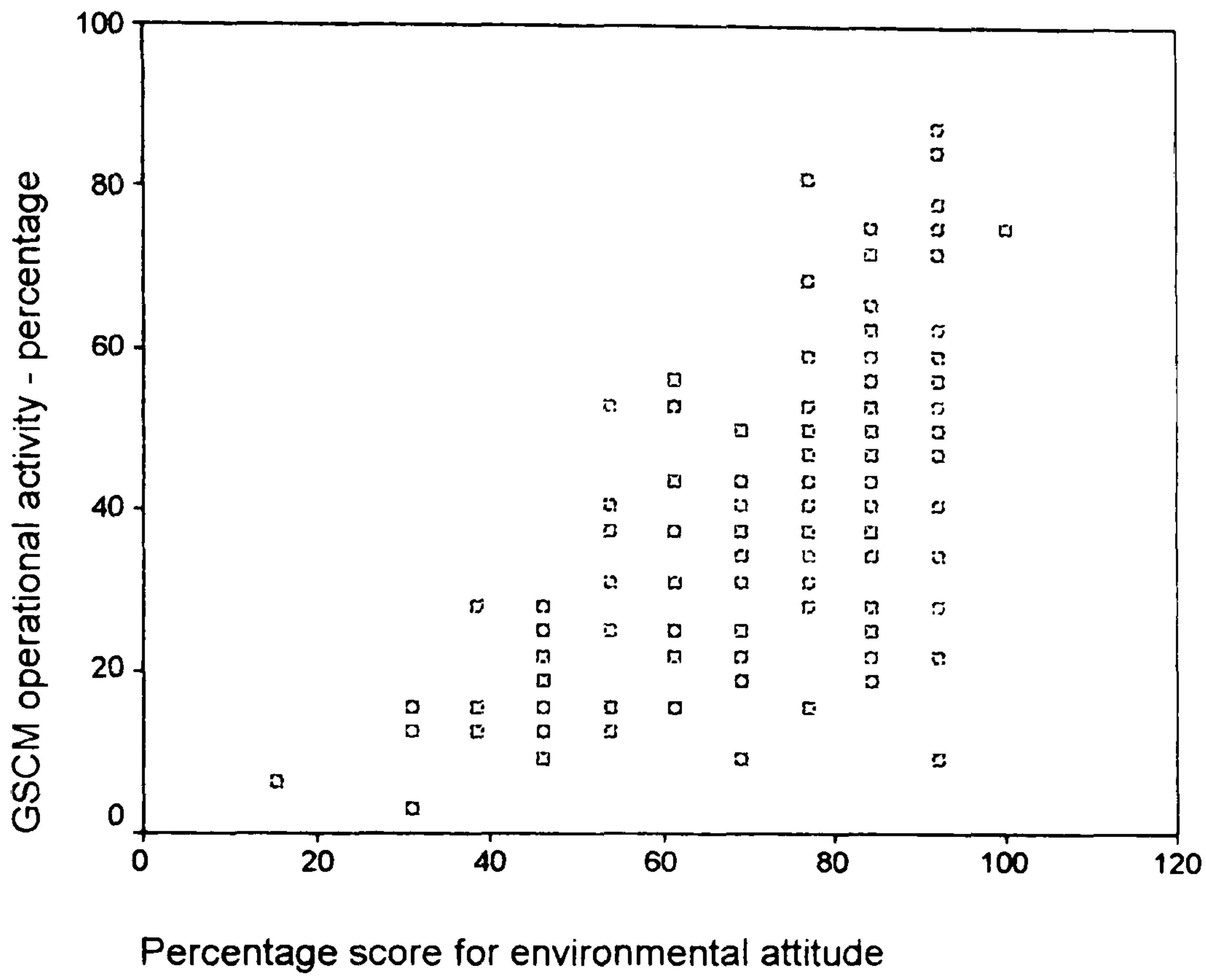

Figure 10.5: Scatterplot of total green supply chain management operational activity and environmental attitude

However, the scatter plot of the relationship between attitude and total green supply chain management activity suggests that other variables may be influential, as the spread of the data suggests heteroscedasticity. Tabachnick and Fidell (1983) suggest when heteroscedasticity exists that a multiple regression can be undertaken that adds in other variables that may be influencing the relationship that exhibits heteroscedasticity.

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this test is used as a guide only and this relationship is explored further using the correlations between environmental attitude and total operational activity scale variables.

[7] As indicated in table 10.1.

10.4.2 Exploring Operational Activity – Multiple Regression

This section explores the relationship between the pressures driving green supply chain management (from external drivers, environmental attitude and internal drivers) and the possible resultant green supply chain management practices. Section 10.2 presents two levels of analysis when assessing the relationships in the green supply chain management model;

- the simplistic approach that uses the summative environmental pressure variable developed in section 7.4.3; and
- the advanced approach that uses each of the external driver scales.

Each of these are examined in turn in this section.

10.4.2.1 Simplistic Green Supply Chain Management Model

Entering the variables that measure the summary external drivers, internal drivers and environmental attitude simultaneously into a simple multiple regression to predict total green supply chain management operational activity, produces a solution with **r = 0.690** and $R^2 = 0.476$ (significant at $p<0.000$). Therefore, the regression equation explains 47.6% of the variance in the sample.

The F value in table 10.5 is significant suggesting that the R^2 value produced reflects a real pattern in the population examined. The standardised beta coefficients are positively distributed for environmental attitude (0.521), external pressure (0.201) and internal drivers (0.045) indicating a positive direction in the relationship between these variables, i.e. as the strength of these increases, there is an increase in levels of total green supply chain management activity.

Environmental attitude has the greatest beta value (0.521) and has the greatest effect upon total green chain management operational activity and internal drivers the least. The tolerance level is >0.2+ and VIF <5, indicating multicollinearity is not a problem in the solution.

Table 10.5: Results from simple (enter) multiple regression of total green supply chain management operational activity

	Sum of Squares	df	Mean Square	F	Sig.
Regression	20436.54	3	6812.180	38.779	.000
Residual	22485.32	128	175.667		
Total	42921.86	131			

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-2.15	8.05		-.267	.790		
External pressure summary (X_{extsum})	3.692	1.79	.201	2.064	.041	.430	2.328
Environmental Attitude ($X_{env\ att}$)	.553	.09	.521	6.421	.000	.622	1.607
Internal Drivers ($X_{int\ dri}$)	.872	1.77	.045	.491	.624	.498	2.006

Dependent Variable: GSCM operational activity - percentage

The regression equation for the above solution is:

Total GSCM[8] (%) = $3.69\ X_{extsum} + 0.55\ X_{env\ att} + 0.87\ X_{int\ dri} - 2.15 + e$[9]

This regression equation (and table 10.5) indicates that environmental attitude is the primary predictor of total green supply chain management activity. If all the other variables remain constant (the external drivers and internal drivers) then an increase in environmental attitude by 1% increases total green supply chain management activity by 0.55%. Similarly, increasing the external drivers by one level of magnitude increases the level of management activity by 3.69%.

8 GSCM – refers to Total Green Supply Chain Management Operational Activity (measured as a %)

9 Any prediction based on a set of coefficients is subject to error (De Vaus 2002:287), defined in this equation as 'e'. Since this figure is not known it is excluded from all subsequent regression equations reported.

The 'enter' method of multiple regressions adds all the independent variables into the equation simultaneously. In order to investigate the relative influence of each independent variable, hierarchical multiple regression can be used. Each variable is entered into the regression equation in their theoretical order of importance. Table 10.6 illustrates the results for this when environmental attitude is entered first, followed by summary of external pressures and internal drivers (the order suggested by the standardised beta values previously in table 10.5)

Table 10.6: Hierarchical regression for simple green supply chain management model

Model	R	R^2	Adjusted R^2	Std. Error	R^2 Change	F Change	df1	df2	Sig. F Change
1 Env att	0.66	0.44	0.44	13.58	0.442	102.87	1	130	0.00
2 Ext. sum	0.69	0.48	0.47	13.21	0.033	8.21	1	129	0.00
3 Internal drivers	0.69	0.48	0.46	13.25	0.001	0.24	1	128	*0.62*

As illustrated in table 10.6 adding the external drivers and internal drivers to the solution explains very little additional variance, (3.3% and 0.1% respectively). The variance change for the internal drivers is not significant. Table 10.6 **confirms the finding in section 10.2 that environmental attitude is the primarily predictor of total green supply chain management activity. The influence of the external drivers is primarily indirect,** with only 3.3% of additional variance explained by the external driver scale (as suggested by the elaboration analysis in section 10.2)[10].

[10] A stepwise multiple regression produces the same solution with environmental attitude identified as the main predictor, with additional variance explained by a composite of external and internal drivers. The use of the hierarchical regression technique allows the non-significant influence of the internal drivers to be discounted in a way that stepwise regression cannot.

10.4.2.2 Advanced Green Supply Chain Management model – multiple regression

When the advanced model of green supply chain management is examined (figure 10.2) including all the individual external drivers (rather than the summative variable used in section 10.4.2.1), internal drivers and environmental attitude, the multiple regression solution improves slightly on that in section 8.4.2.1 (from r = 0.69 to r = 0.708)

To detangle the relative influence of all of these variables a stepwise multiple regression can be used. This produces a solution of r = 703, identifying the environmental attitude variable and legislative driver variables as statistically significant at $p<0.01$[11]. This solution explains 49.5% of the variance in green supply chain management activity in the sample. The addition of the legislative driver, to that of environmental attitude improves the solution slightly, by 5.3%. The results from the stepwise regression can then be used to guide the hierarchical multiple regression solution reported in table 10.7. The results from the stepwise solution dictate the order in which the variables are entered into the regression equation based on their perceived level of importance to the solution. These were entered as (1) environmental attitude (2) legislation (3) internal drivers (4) societal drivers (5) supply chain (6) competitive.

Table 10.7: Hierarchical regression of advanced green supply chain model

Model	R^2	Adjusted R^2	Std. Error	Change Statistics	R^2 Change	F Change	df1	df2	Sig. F Change
1	.665	.442	.437	13.58	.442	102.87	1	130	**.000**
2	.703	.495	.487	12.97	.053	13.52	1	129	**.000**
3	.704	.496	.484	13.01	.001	.208	1	128	.649
4	.704	.496	.480	13.05	.001	.186	1	127	.667
5	.707	.500	.480	13.06	.003	.840	1	126	.361
6	.708	.502	.478	13.08	.002	.514	1	125	.475

[11] Solution not reported in the text – but used as a basis for the hierarchical regression in

As indicated in table 10.7, only the first two solutions, (environmental attitude and legislative factors) produce statistically significant changes in the multiple regression equation. The hierarchical regression technique allows the influence of each relative independent variable to be statistically tested. The detailed regression statistics for this solution are presented in appendix 15.

This solution proves that only the legislative drivers add significantly to the influence of the environmental attitude variable.

10.4.2.3 Total Green Supply Chain Operational Activity – the summary model

Based on the statistics presented in section 8.4.2.2, a generic model can be developed that predicts operational activity from the legislative drivers and environmental attitude, detailed in table 10.7 and 10.6. The regression statistics for this equation are presented in table 10.8

Table 10.8: Regression estimates for generic green supply chain management model

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-20.10	5.37		-3.75	0.00		
Environmental Attitude ($X_{env\ att}$)	0.51	0.08	0.47	6.68	0.00	0.73	1.37
Legislation drivers X_{leg}	6.42	1.33	0.34	4.81	0.00	0.73	1.37

Total GSCM (%) = $0.51\ X_{env\ att} + 6.42\ X_{leg} - 20.1$

Based on this equation, for every 1% increase in environmental attitude (when legislative drivers remain constant) total green supply chain management activity increases by 0.51%. When environmental attitude remains constant, an increase in the level of the legislative drivers

table 10.7

increases operational activity by 6.4%[12]. Environmental attitude has the most influence (standardized beta 0.47) compared with the legislative drivers (beta = 0.34).

This solution is described above as a **'generic'** solution and reflects the fact that the organisational contingencies of the respondents have not been taken into account. The effect of these contingencies is explored in section 10.5.

Before these are examined the six specific categories of green supply chain management activity used to develop the total green supply chain management dependent variable used in these multiple regression solutions, are explored (section 10.4.2.4).

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12 The scales for environmental attitude and legislation are different and therefore not directly comparable (De Vaus 2002: 380). The legislative drivers are based on the Likert scale so an increase of 1 reflects an increase in magnitude. Whereas, the environmental scale is based on a percentage score developed from the indicator questions discussed in chapter 8.

10.4.2.4 *Examining category specific activity*

This section uses stepwise multiple regressions to examine the influence of the external drivers and internal factors on each 'type' of operational activity. Two solutions are explored, firstly the influence of each of the external drivers and the internal driver, without the influence of environmental attitude. In the second solution environmental attitude is reintroduced (table 10.9).

Table 10.9: Specific green supply chain management operational activity and the influence of individual external drivers (1) and with environmental attitude included (2)

Specific Operational Activity	(1) Significant Influences without environmental attitude	R^2	(2) Significant with environmental attitude	R^2
Supplier Education Coaching and Mentoring	Legislative	0.361	Environmental Attitude (0.481)	0.481
Green Procurement and Logistics Policy	Legislative (0.354) Societal (0.203)	0.541	Legislation (0.350) Environmental Attitude (0.286)	0.555
Internal Env. Operations Mgt.	Legislative	0.398	Environmental Attitude (0.408) Legislation (0.177)	0.522
Green Logistics	Societal	0.273	Environmental Attitude (0.391)	0.391
Supplier Assessment	Legislative	0.390	Environmental Attitude (0.4) Societal (0.183)	0.504
Industrial Networks	Legislative	0.393	Legislation (0.41)	0.41

The justification for exploring each of these categories of activity with and without environmental attitude is that specific management activity may be more sensitive to specific external pressures, such as the influence of supply chain drivers on supplier assessment practices. The previous section demonstrates that environmental attitude is the primary driver of total green supply chain management operational activity and it's influence 'overwhelms' all of the other external drivers except legislation. A simple regression between total green supply chain management and all the external drivers[13]

[13] Statistics not detailed in text

without environmental attitude produces a correlation co-efficient of r = 0.611 (37.3% variance explained), compared with the optimum solution presented previously in table 10.8 where r = 0.703 (49.4% variance explained). This suggests that external drivers act 'through' environmental attitude, but may also reflect that environmental attitude is a composite of all the external and internal pressures an organisation experiences. To explore the relative influence of different intensities of external pressure it is important to present solutions where initially the environmental attitude of the organisation is excluded.

Table 10.9 uses stepwise regression to explore the relative influence of different external drivers on each of the specific types of green supply chain management activity. An examination of table 10.9 presents some interesting findings. When environmental attitude is removed from the regression equations then legislation and societal drivers become the main predictor variables. However, reintroducing environmental attitude replaces these variables as the main predictor in supplier education, internal environmental management, green logistics and supplier assessment. Yet, legislative factors remain the primary predictor of operational activity of green procurement and logistics policy and the only predictor in industrial networks. However, inclusion of the environmental attitude variable improves the regression solution in all six categories of operational activity.

These findings suggest that:

- There are subtle differences in the influential factors affecting different categories of green supply chain management activity, that are obscured by using the total green supply chain management activity measure;
- That in most cases environmental attitude substitutes for the external drivers as the primary predictor of operational activity, confirming that external drivers mostly impact indirectly through the internal environmental attitude of an organisation;
- That industrial networks are driven by legislative pressure, perhaps

reflecting that such outreach activities only occur when the 'threat' of environmental legislation is greatest; and

- In a similar manner, green procurement and logistics practices appear to be primarily related to legislation where again the 'threat' of environmental issues in the external environment appears to force organisational responses, as opposed to a voluntary choice by organisations.

10.5 Assessing the Influence of Organisational Contingencies

Throughout chapters 7, 8 and 9 the potential moderating influence of organisational contingencies upon the green supply chain management model previously discussed in chapter 3 (section 3.3.4), is examined. These contingencies potentially act as a 'filter' altering the influence of the independent variables in the green supply chain management model. The effect of each of the selected organisational contingencies on **individual** variables is examined in these previous chapters, and is summarised in table 10.10. However, this table does not establish whether these contingencies have demonstrable effects upon the relationships in the green supply chain pressure/ response model tested in this chapter. The potential moderating effect of these is the focus of this particular section. In section 10.4.2.3, a hierarchical multiple regression of all the external drivers, internal drivers and environmental attitude, provided a solution whereby total green supply chain management activity is determined by environmental attitude and legislative drivers. However, the dataset used to provide this solution was deliberately gathered from a cross-sectoral, diverse sample. Potentially this heterogeneity could influence the relationships identified in the generic model in section 10.4.2.3. Thus organisational contingencies might be used to see whether these generic relationships are influenced by specific organisational characteristics of the respondents.

The organisational contingencies in table 10.10 are a mixture of categorical and dichotomous variables. De Vaus (2002:368) discusses the use of such variables in SPSS multiple regression equations. Four organisational contingencies are used in this section to explore their influence upon the advanced green supply chain management model proposed in section 10.4.2.2[14]. These are: sector; size; potential environmental impact; and potential environmental risk. These are chosen as they demonstrate the most influence on individual variables in the green supply chain pressure/response model as indicated in table 10.10[15].

Two of these organisational contingencies are dichotomous (potential impact and risk) and can be included in the multiple regression equation. The third variable, 'size', is recoded into a dichotomous variable of small/medium or large (where large is 250 employees+). The reason for this is that standard definitions of size typically use this break point as the division between large and SME sized organisations. Secondly, in previous chapters the large 'group' is divided into large and very large (1000+) in order to explore subtle differences in specific aspects individual constructs. This division is not used in official size designations (such as those used by the DTI and the EU) and it is therefore valid to collapse these size categories into SME or large (250+ employees).

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[14] Although section 10.4.2.3 identifies that only legislation and environmental attitude are significant in the advanced model presented in 10.4.2.2 all the internal factors and external drivers are reintroduced in case the demographic characteristics change the significance of some of these variables.

[15] Although the 'market type' characteristic produces a number of statistically significant variations between groups for individual variables, it is excluded from this analysis. Sector provides some indication of market type with significant differences in market type mirroring significant difference in sector, with the exception of internal obstacles which are not included in the model at this level of analysis (as discussed in section 10.3).

Table 10.10: Summary of influence of organisational contingencies upon each of the individual measures within the green supply chain management pressure/response model[16]

	Obstacles		Internal		External Drivers					Green Supply Chain Management Operational Practices						
	Internal Obstacles	Supplier Obstacles	Environmental Attitude	Internal Drivers	Summary External	Supply Chain	Competitive Factors	Legislative I Pressure	Societal	Green Procurement and Logistics Policy	Environmental Operations Management	Supplier Assessment, Evaluation	Supplier Education Coaching and Mentoring	Green Logistics	Industrial Networks	Total operational Activity
Size Classification			✓a	✓a	✓a			✓a	✓a	✓a			✓a	✓b	✓a	✓a
Sector				✓a	✓b			✓a	✓a	✓a					✓a	✓b
Market	✓b				✓a			✓a	✓a	✓a						✓b
Customer Dependency						✓a	✓a									
Supplier Dependency																
Possible Environmental Risk			✓a	✓a	✓a			✓a	✓a	✓a	✓a		✓b			✓a
Possible Environmental Impact			✓a	✓a	✓a			✓a	✓a		✓b		✓b			✓a

Key: ✓a - significant differences between groups at p<0.01 ✓b - significant differences between groups at p<0.05

[16] summarized from table 7.12, 8.21 and 9.14

The final characteristic, sector, is a nominal variable. Therefore, it is incorporated into the multiple regression equation based upon the protocols described by De Vaus (2002:272) for using dummy variables in multiple regression techniques. Each of the sectoral groups is recoded into a dummy variable and entered in a block in the multiple regression equations (precluding the use of stepwise regression). The addition of these dummy variables brings the total number of independent variables in the multiple regression tests to 12 (4 external variables, internal drivers, environmental attitude, size, risk, impact and five dummy sectoral values). Since this now exceeds the ratio of dependent variables to cases suggested by most authors is important to reduce the number of independent variables used in the final solution.

To address this issue, the influence of sector can be explored using the summative external pressure variable (rather than the four individual external driver variables). Entering the dummy sectoral values into the simplistic green supply chain model from section 10.4.2.1 improves the r value from 0.690 to 0.723 (changing R^2 from 0.476 to 0.523). At $p<0.01$ only two variables are significant, environmental attitude with a standardized beta value of 0.558 and the manufacturing variable (beta -0.244). Adding the other three organisational contingencies improves the solution to $r = 0.757$ ($R^2 = 0.574$), but now only environmental attitude (beta 0.526) and size (beta -0.211) are significant. This suggests that any possible influence of sector is encapsulated by the other organisational contingencies (specifically size). Because of this it is arguably valid to exclude sector from the further calculations, and thus simplifying further regression calculations.

Testing the model with size, risk and impact

A stepwise multiple regression that includes all the individual external drivers, internal driver, environmental attitude and the three organisational contingencies of size, risk and impact produces a model fit of $r = 0.732$, with environmental altitude ($p=0.00$), large/SME ($p=0.00$) and legislative drivers ($p=0.04$) retained as significant in the model.

Entering the variables into a hierarchical multiple regression based on their beta values[17], produces a solution of r = 0.732, as illustrated in table 10.11. The R^2 change is only significant for environmental attitude, size and legislation at $p < 0.01$.

Table 10.11: Green supply chain management model including effects of demographic characteristics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.67	0.45	0.44	13.52	0.45	104.28	1	128	0.000
2	0.71	0.50	0.50	12.87	0.06	14.29	1	127	0.000
3	**0.73**	**0.54**	**0.52**	**12.51**	**0.03**	**8.42**	**1**	**126**	**0.004**
4	0.74	0.55	0.53	12.43	0.01	2.64	1	125	0.107
5	0.75	0.56	0.54	12.30	0.01	3.63	1	124	0.059
6	0.75	0.56	0.54	12.32	0.00	0.68	1	123	0.412
7	0.75	0.56	0.54	12.35	0.00	0.38	1	122	0.538
8	0.75	0.56	0.53	12.40	0.00	0.03	1	121	0.862
9	0.75	0.56	0.53	12.45	0.00	0.01	1	120	0.943

1 Predictors: (Constant), Percentage score for environmental attitude
2 Predictors: (Constant), Percentage score for environmental attitude, size recoded
3 Predictors: (Constant), Percentage score for environmental attitude, size recoded, average score for legislation drivers

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
4	(Constant)	-9.92	5.99		-1.657	0.100
$X_{env\ att}$	environmental attitude %	0.53	0.08	0.49	6.787	0.000
X_{size}	size	-7.77	2.51	-0.20	-3.093	0.002
X_{leg}	Legislative drivers	4.05	1.40	0.22	2.902	0.004

Based on the findings in table 10.11 an optimal multiple regression solution is presented below that incorporates the organisational contingencies.

$$\textbf{Total GSCM (\%)} = 0.53\, X_{env\ att} + 4.05\, X_{leg} - 7.77\, X_{size} - 9.92$$

Environmental attitude (standardized beta= 0.49) has the most influence

[17] 1 environmental attitude, 2 size, 3 legislative, 4 supply chain, 5 impact, 6 societal, 7 competitive, 8 risk and 9 internal.

followed by legislation and size. The coefficients indicate that the SME group are 7.77% **less** operationally active than the larger group. This solution is slightly better than the generic solution presented in table 10.7, improving from $r = 0.703$ (49.4% variance explained) to $r = 0.732$ (53.6% variance explained).

Therefore, only the organisational contingency of size significantly moderates the green supply chain management model at $p<0.01$. However, the predominant determinant of green supply chain management activity remains the environmental attitude of respondents, with some influence from legislative drivers.

10.6 Further examination of contingencies

To explore the validity of the generic model proposed in the previous section it is important to retest the model controlling for each of the contingencies in turn. In this section the multiple regression equations are re-run, controlling for both the contingencies included in the original calculations, and those that were not (such as supplier dependency). However, it is important to note that since the dataset is further reduced by this selection process, some organisational groups do not really have enough members to pass the ratio of cases to variables suggested by De Vaus and others. Thus, the findings presented here remain exploratory.

As table 10.12 indicates the general pattern established in section 10.5 of green supply chain management activity predominantly controlled by environmental attitude, and to a lesser extent size and legislative drivers, remains valid. In all cases the environmental attitude explains the majority of variance in activity. None of the other independent variables (such as societal, supply chain, competitive or level of environmental impact / risk) are re-introduced into the model when these contingencies are controlled. In a few cases environmental impact is highlighted in the multiple regression equations but only at $p<0.05$, and has been excluded from the final solutions.

Table 10.12: Testing the model when controlling for organisational contingencies

					Significant variables in the model (at p<0.01)			
Controlling for		n	R	R^2	Env. attitude	Size	Legislative	constant
Size	SME	45	0.774	0.599	0.636			-11.859
	Large	104	0.634	0.402	0.443		7.006	-15.365
Risk	Higher	58	0.612	0.375	0.680			-7.160
	Lower	89	0.754	0.569	0.496	-9.830	3.949	-6.944
Impact	Higher	68	0.775	0.601	0.728	-12.773		-5.568
	Lower	80	0.666	0.443	0.437		5.217	-12.422
Sectoral class	Manufacturing	44	0.772	0.596	0.692	-11.261		-8.487
	Public	44	0.638	0.407	0.739			-6.357
Customer dependency	Low	71	0.753	0.567	0.588		5.88	-21.569
	Moderate and low	124	0.745	0.555	0.567	-6.916	3.767	-11.610
Supplier dependency	Moderate and low	104	0.732	0.536	0.567		4.747	-17.448
Generic solution		*149*	*0.732*	*0.54*	*0.53*	*-7.77*	*4.05*	*-9.92*

The direction of the beta values also remains constant in table 10.12 when compared with those of the generic solution. The findings presented above confirm that the only organisational contingency within the generic model that influences the multiple regression solution is that of size. When this factor is controlled only environmental attitude determines activity (at r = 0.777). It is also apparent that in the higher risk organisations size is not a factor, whereas it is in the lower risk group suggesting that smaller organisations that do not pose significant environmental risk are less operationally active. Yet in contrast in the higher environmental impact group, smaller higher impact organisations are less active than the higher impact larger organisations. Perhaps whilst there is a perception of high environmental impact, it is only where this impact is also linked to significant risk is operational activity more intense.

10.7 Discussion

Figure 10.6 presents the final version of the green supply chain pressure/response model, based on the proofs presented in this chapter. There are also two 'additional' elements added to this model – organisational contingencies (demographic characteristics) not used in the multiple regression equations and 'unmeasured variables(s)' reflecting any latent variables not captured by the research instrument.

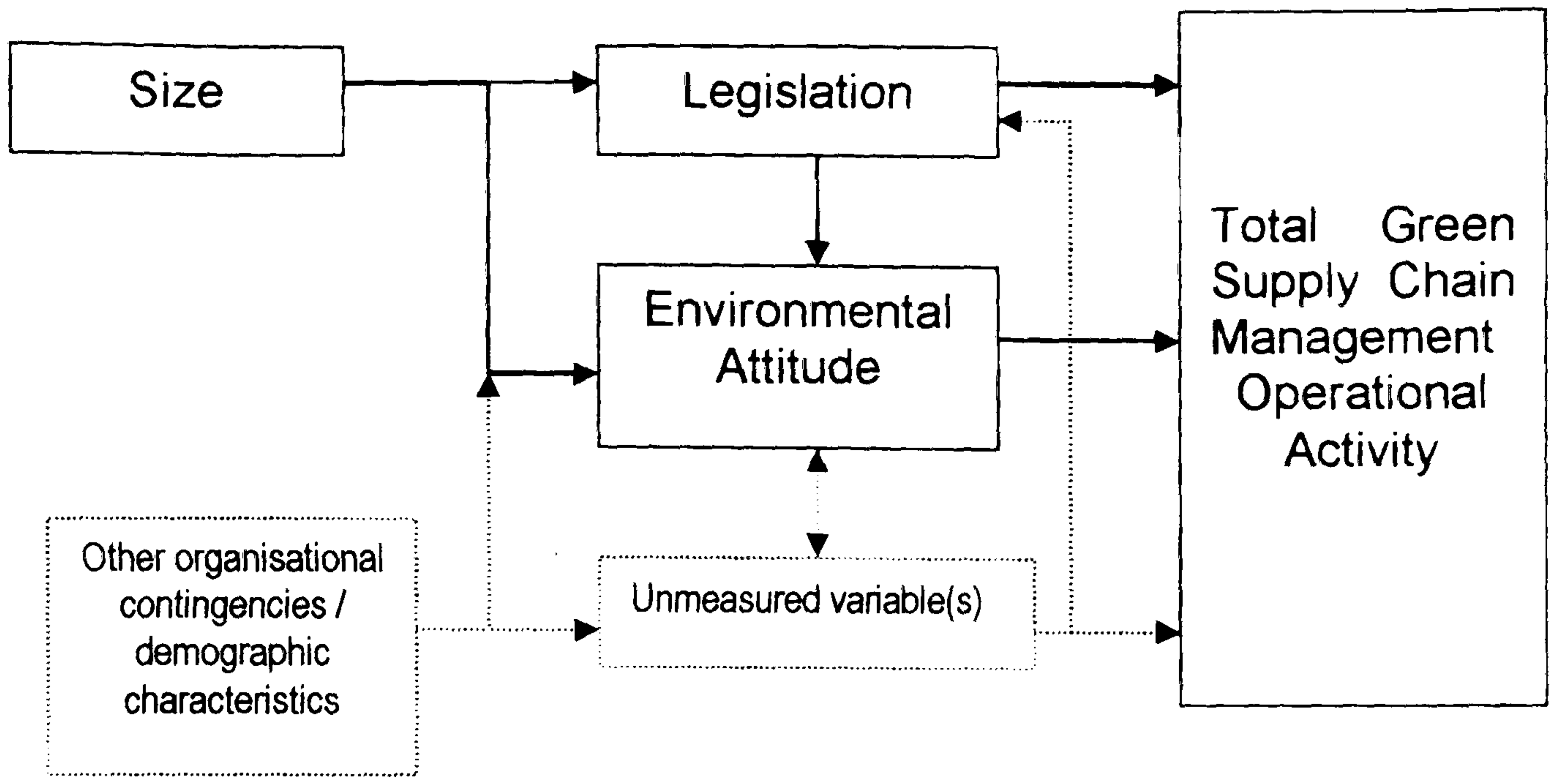

Figure 10.6: Statistically significant relationships in the green supply chain pressure/response model

This final section of this chapter now examines how the findings presented here in this chapter relate to those presented in previous studies. There are a number of empirical studies on aspects of green supply chain management, detailed in appendix 1.1. However, the majority of these use only descriptive analysis to explore their findings. The findings from many of these are discussed within chapters 7-9 where appropriate. Whereas, this chapter focuses upon previous studied that have statistically tested various aspects of green supply chain management.

Since the development and testing of the pressure/response model of green supply chain management in this chapter is a new contribution to green supply chain management research, it cannot be directly compared with other studies, although there are similarities as illustrated in table 10.12. The key points from this comparison are:

- Only two studies can be identified that statistically test a model of green supply chain management practices in relation to driving forces (Rao 2002, Bowen *et al.* 2001b);
- There are three additional studies that only statistically test green

purchasing behaviour (Carter and Carter 1998; Carter *et al.* 1998; Carter and Jennings 2002);

- The remaining models identified in table 10.12 are all associated with internal environmental management practices and marketing;
- There are four cross-sectoral studies (Rao 2002; Bowen *et al.* 2001b, Langerak *et al.* 1998; Henriques and Sadorsky 1996) but none test their organisational contingencies on their models;
- Only Bowen *et al.* (2001b) adopts a measure of operational activity developed from specific actions, rather than opinions (Rao 2002), or a single operational measure (Henriques and Sadorsky 1996); and
- Only Langerak *et al.* (1998) uses partial correlations to control for the influence of a third variable.

The findings presented in this chapter culminate in figure 10.6 with the identification of statistically significant relationships in the green supply chain pressure/response model. These are:

- **The positive relationship between environmental attitude and green supply chain management activity;**
- **The positive relationship between legislative drivers and green supply chain management operational activity;**
- **The moderating effect of industry size upon these relationships; and**
- **None of the other external drivers or internal drivers statistically improves the model presented.**

Table 10.13: Specific studies that statistically test models or relationships in aspects of green supply and associated environmental management/marketing

Reference	Focus	Type of statistical tests	Key similarities	Key differences
Rao 2002	Models and tests green supply chain management practices and drivers in leading edge **Green Supply**	Structural equation models	Tests model uses constructs that measure operational activity	Cross-sectoral but sample selected to choose only those that were most proactive. Main focus of model on environmental and economic performance measures. Likert scale responses for operational activity rather than yes/no No examination of influence of organisational contingencies
Bowen *et al.* (2001b)	Green supply chain management capabilities and operational activities **Green supply**	Structural equation models	Cross sectional. Provides empirical proof of relationship between proactivity of approach and likelihood of implementation of green supply. Use measure of operational activity based on yes/no responses	No examination of industry contingencies in model. Primary focus on internal supply chain management capabilities
Carter and Carter 1998	Models and tests interorganisational factors and how they affect environmental purchasing **Environmental Purchasing**	Structural equation models	Used four sectors (regulatory, output, input and competitive) similar to the external drivers advanced green supply chain management model	Did not examine internal organisational factors. Limited sectoral focus. No examination of organisational contingencies
Carter *et al.* 1998	Test difference between levels of environmental purchasing in US and Germany **Environmental Purchasing**	Discrimiant analysis	Develops environmental purchasing scale. Examines internal company factors associated with management commitment.	Limited sector focus. No examination of organisational contingencies except nationality

Carter and Jennings 2002	Models and tests relationship between PSR and relationship with suppliers **Socially Responsible Purchasing(PSR)**	Structural equation models	Development of scale variables	Specific focus on purchasing and suppliers rather than wider green supply. Limited sectoral focus No examination of organisational contingencies
Banerjee *et al* 2003	Influence of antecedent and industry type on corporate environmentalism **Environmental Strategies and Marketing**	Mean scores and path analysis in Lisrel	Examination of influence of industry type. Examines external and internal drivers and operational activity	Only looks at level of environmental impact as contingencies. Not focussed on green supply. Operational measures based on opinion statements rather than specific operational practices
Schaper 2002	Green behaviour amongst retail pharmacies in Western Australia **Environmental Management**	Bivariate tests	Looks at environmental attitude and how this relates to behaviour	Environmental attitude of owner manager not organisation SME sample only single sector
Ghobadian *et al.* 2001	Models a range of factors driving and moderating environmental strategies **Environmental Strategies and Policy**	Theory only	Suggests influence of leadership in organisations is critical – related to environmental attitude measure	Not tested – focus on environmental strategies is not green supply chain management
Langerak *et al.* 1998	Models antecedent of green marketing **Green Marketing**	Partial correlations	Cross sectional. Used measure of sensitivity to business environment similar to environmental; attitude. Used similar external drivers	Focused on marketing. Based in Netherlands No examination of organisational contingencies
Henriques and Sadorsky 1996	Empirically tests the determinants of an environmentally responsible firm **Environmental Management**	Logit regression	Looks at external and internal drivers Cross sectional. Discusses influence of sector and size	Only uses sector in statistical model not size. Uses extent of environmental plan as only operational measure

10.7.1 External Drivers

Carter and Carter (1998) state that in their study a link between regulation and extent of green purchasing cannot be supported, whereas in this study legislation is the second most influential factor and is significantly related to green supply chain management activity. This difference may be related to the use of a cross-sectoral sample in the study reported here where different levels of regulation will be experienced. Henriques and Sadorsky (1996) in their cross-sectoral study found that the effect of government regulation on the development of an environmental plan was significant at $p<0.05$, and developed a regression equation that predicted how increasing governmental legislation would increase the likelihood of an environmental plan. Sarkis (1998) incorporates regulation into his theoretical model of environmentally conscious business practices, suggesting that operational activity is related to the type of regulatory environment in which an organisation is situated. Langerak *et al.* (1998) found a statistically significant link between levels of regulation and green marketing activities, which is arguably an outcome of a successful green supply chain programme. The importance of regulation as a driver of green supply chain management practices is confirmed in this study by it's presence in figure 10.6.

There appears to be a link between levels of legislative pressure and the moderating influence of levels of environmental impact and size in the model presented in figure 10.6. Henriques and Sadorsky (1999:94) found that firms in more highly regulated industries were more likely to embed environmental issues into their business strategies than those in less regulated ones. These industries would arguably be more visible due to their higher levels of environmental impact, although they do not test for the statistical significance of size. Arguably these organisations would be larger as suggested by figure 10.6. A study of SMEs by Baylis *et al* (1998b) found that firms involved in Permit based regulation, i.e. those affected by statutory environmental responsibilities, had higher levels of green policy development. It could be suggested that those organisations with higher potential levels of environmental impact will be constrained by specific environmental legislation designed to minimise that potential impact, supporting the moderating influence of levels of environmental impact in figure 10.6. Banerjee *et al.* (2003) also found a link between level of environmental impact and corporate environmentalism – where the regulatory environment for organisations with high environmental impacts, and public concern, had the greatest impact on the type of environmental strategies and level of environmental operational activities.

In the Henriques and Sadorsky (1996) study, customers and community were also driving forces of environmental activity, but this contradicts the finding presented here as they were excluded in the green supply chain management regression solutions due to their insignificant effect. Competitive factors were also included as statistically significant predictors of green marketing practices in Langerak *et al.* (1998). This might be expected given that green marketing involves promoting an organisation to gain a competitive advantage through its environmental activities. Yet Langerak *et al.* (1998) found no support for the influence of customer pressure.

10.7.2 Environmental Attitude and Internal Drivers

Carter and Carter (1998) develop and test a model that examines the interorganisational factors that drive and constraint environmental purchasing. However, their focus is only on environmental purchasing, and excludes the influence of internal organisational factors, suggesting that future studies should involve an examination of these. Ghobadian *et al.* (2001) also drew attention to the overwhelming importance of 'leadership' as a mediating factor in the development of environmental strategies. Halme (2002) stated that shifts in corporate environmentalism can be set in motion by external pressure but it requires internal factors where an organisation learns a *'new meaning of their own to support new environmentally sound forms of activity'*

Bowen *et al.* (2001b) presented the first empirical proof that an environmentally proactive corporate stance fostered capabilities in environmental management at a sub-organisational level. This 'proactivity' is a reflection of environmental attitude and the findings in this study support those of Bowen *et al.* (2000b) who demonstrated that as proactivity increase the likelihood of implementation of green supply chain management practices also increases. Yet, Schaper (2002) found no statistically significant link between environmental attitude and resultant 'green' business behaviour amongst a sample of retail pharmacy SMEs. However, that study used the personal environmental attitudes of the owner/ manager as the predictor, whereas this study concentrates on organisational values that are arguably more likely to be embedded in standard operational practices.

Findings supported by other empirical studies:

- Influence of legislation as significant driver (Baylis *et al.* 1998b: Banerjee *et al.* 2003; Henriques and Sadorsky 1996, 1999; Langerak *et al.* 1998);
- As organisations become more environmentally progressive in their environmental attitude the likelihood of green supply chain management practice is enhanced (Bowen *et al.* 2001b; Drumwright 1994; Lamming and Hampson 1996; Min and Galle 1997); and
- Customer pressure is not influential (Langerak *et al.* 1998).

10.7.3 Organisational Contingencies

Organisational contingencies are rarely tested in the previous empirical models with only Henriques and Sadorsky (1996, 1999) finding a link with sector, and level of environmental impact identified as significant in Banerjee *et al.* 2003. The influence of size is discussed anecdotally in a number of studies such as Autry *et al* (2001), Baylis *et al.* (1998c), Florida (1996), Hall (2000), and Murphy and Poist (2000). However, most previous studies that report quantitatively on findings related to organisational size only describe the findings. None specifically add organisational contingencies, such as size, sector, environmental impact and risk, to statistical models.

CHAPTER 11: CONCLUSIONS

11.1 Introduction

This chapter presents the major findings from this study (section 11.2), major contributions to the field of research (section 11.3), contribution to practice (section 11.4) the limitations to the study (section 11.5), a reflection on the process of the study (section 11.6), and directions for future research (section 11.7).

In this study a pressure response model of green supply chain management is developed inductively, through a literature review and examination of anecdotal examples of green supply chain management practices (chapter 3). This model comprises of three elements: external drivers, internal factors and green supply chain management practices. Each of these is examined in light of the findings of a survey of members of the Chartered Institute of Purchasing and Supply (CIPS). Each of the three elements of the model is examined individually in chapters 7, 8 and 9. This study culminates with the testing of this model through multivariate techniques to explore which factors determine the extent of green supply chain management practices, and the moderating impact of organisational contingencies on these relationships.

11.2 Summary of findings

In this section, the initial model developed in chapter 3 is presented, followed by the final validated model as detailed in chapter 10. As indicated in figure 11.1, the examination of previous studies on aspects of green supply chain management, and examination of anecdotal cases, suggests that green supply chain management practices are a function of external pressures and internal factors. A number of regression models are developed in this study to test these assumptions, the interaction between internal and external factors, and the validity of this initial model.

The first element of the model comprises of the external drivers, incorporating pressures from legislative, societal, competitive and supply chain factors. The final validated model presented in figure 11.2 indicates that the only external driver that significantly determines the extent of green supply chain management practices in the organisations surveyed is the legislative driver.

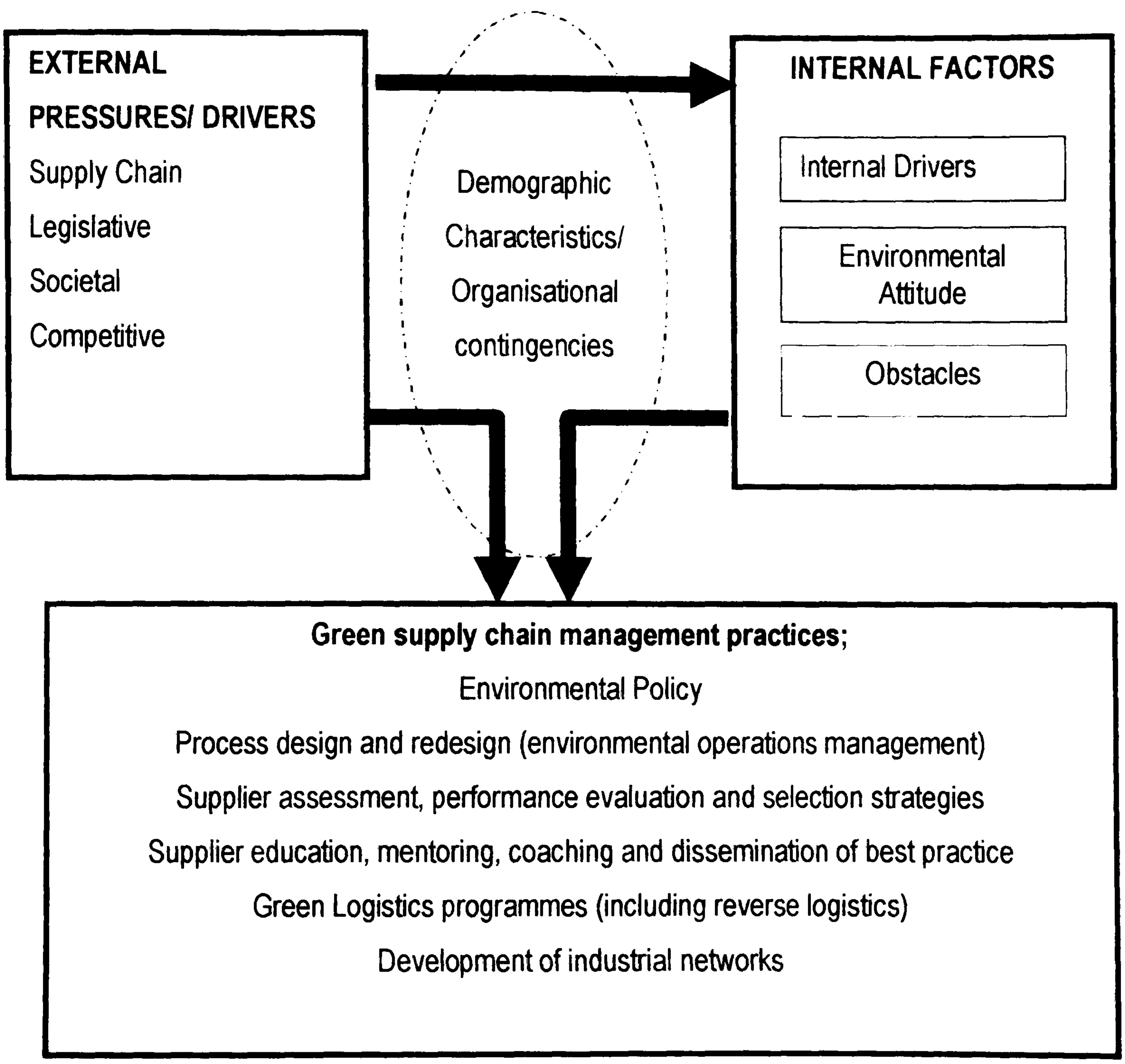

Figure 11.1: Initial pressure / response model of green supply chain management

The internal factors in the initial model consist of internal drivers, obstacles to green supply and a construct developed to measure environmental attitude (after Murphy *et al.* 1996). As indicated in figure 11.2 and discussed in detail in chapter 10, it is ultimately the environmental attitude that determines the majority of the variance in green supply chain management activity. None of the other internal factors are statistically significant within the final model.

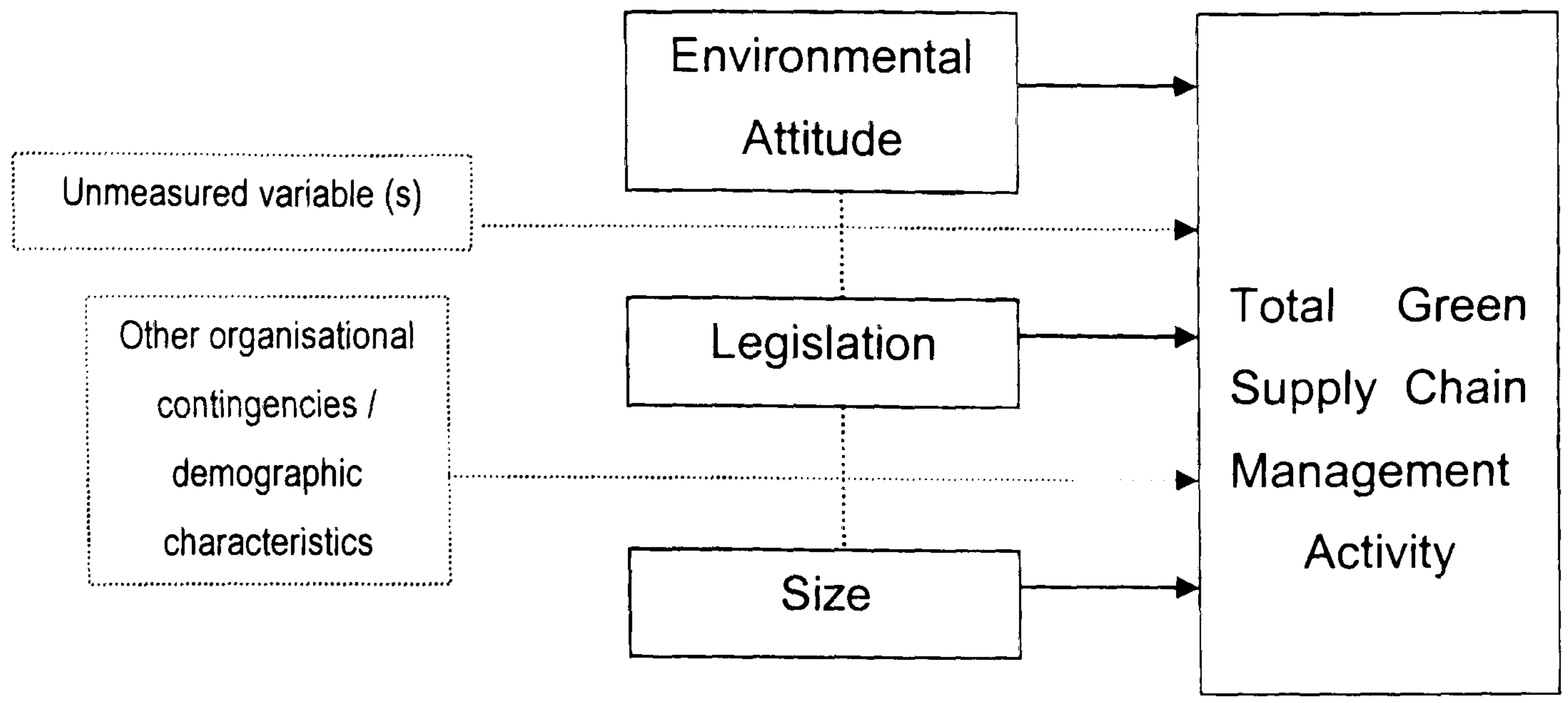

Figure 11.2: The final pressure/ response model of green supply chain management

Whilst previous studies have referred to the impact of some organisational contingencies (as discussed in detail in chapter 6) on green supply chain management, this has not been comprehensively tested in a similar manner to this study. Examination of each element of the initial model proposed in figure 11.1 does suggest that some organisational contingencies affect *individual* variables in the model. However, only size significantly moderates the relationships in the final green supply chain model presented in figure 11.2.

A re-test of the final model controlling for various organisational contingencies is presented in section 10.5. The results of these multiple regression models confirm the validity of the final model presented in figure 11.2. In all instances, when different organisational contingencies are controlled, environmental attitude remains the dominate variable explaining variance in green supply chain management activity. In some instances the variables of size or legislative drivers are excluded from the regression solutions when the organisational contingencies are controlled at $p<0.01$, but remain significant at $p<0.05$. None of the other factors presented in the initial model in figure 11.1, are significant when the contingencies are controlled. Therefore, only the environmental attitude variable explains the majority of variance in the extent of green supply chain management practices, with size and legislative factors influential to a lesser extent.

Table 10.11 illustrates the optimal regression model for the green supply chain management pressure/ response model developed in this thesis (based on figure 11.2). This model which includes all the external drivers, internal driver, environmental attitude and three organisational contingencies (size, level of environmental impact and environmental risk) in a hierarchical multiple regression explains 54% of the variance in green supply chain management activity.

$$\textbf{Total Green Supply Chain Management Activity (\%)} = 0.53\, X_{env\ att} + 4.05\, X_{leg} - 7.77\, X_{size} - 9.92$$

The dominant influence of environmental attitude within these regression models of green supply chain management suggests that the internal environmental culture of an organisation predominantly determines the nature of green supply chain management practices. The indirect effect of the external drivers on environmental attitude (section 10.3) suggests that the environmental attitude measure used in this study may represent a unitary measure of all the external drivers, in combination with the internal environmental culture of an organisation. This suggests that future research should further explore sub-elements of the environmental attitude construct, to further define this highly important determinant of green supply chain management practices.

Environmental legislative is also a significant factor in the final regression model and is the strongest external driver for all organisations (Table 7.12). Within this final regression model (table 10.11) legislation explains an additional 3% of the variance. Whilst this is a relatively small additional variance compared to the overwhelmingly dominant environmental attitude variable (44% variance explained), it does confirm the findings of other studies such as Baylis *et al.* (1998b), Hill (1997) that environmental legislation is the key *external* driver.

Table 10.10 indicates that individual variables in the proposed green supply chain management model (figure 11.1) demonstrate statistically significant differences based on a number of organisational contingencies.

However, supplier dependency does not moderate any of the individual variables in this model and customer dependency only moderates the level of supply chain external pressure and competitive external pressures. This suggests that although 'channel power' is identified in chapter 6 as potentially influential, this construct has no effect upon green supply chain management practices, or each of the sub-categories of types of green supply chain practices.

Three of these organisational contingencies are tested in the final regression model (size, risk and impact)[1]. Additional regression models are also developed that control for these contingencies as discussed in section 10.6. Only size significantly moderates the relationships in the final model (figure 11.2). Potential environmental risk and impact are not statistically significant moderating factors. Table 10.11 indicates that size explains a further 6% of variance in green supply chain management activity, behind that of environmental attitude (44%). The lack of correlation between size and environmental risk/impact suggests tat the influence of size is not encapsulating the other organisational contingencies examined in the regression model, and remains the only significant contingency factor at $p<0.01$.

Obstacles to green supply chain management are not tested in the final regression model as the only statistically significant relationship identified in

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[1] Correlation coefficients between these three contingencies demonstrate no significant relation between size and environmental risk or impact. There is a correlation between risk and impact

the bivariate correlations in Table 10.1 is the correlation between the supplier obstacles and internal obstacles. None of the other individual variables in the model are significantly affected by the level of internal or supplier obstacles. Although section 8.5 describes the extent of each of the individual obstacles to green supply and identifies lack of financial benefit from green supply chain management as the greatest perceived obstacle by respondents, it is clear that the internal and supplier obstacles do not directly affect actual levels of actual green supply chain management activity.

Therefore in summary, the initial green supply chain management model proposed in chapter 3 has been tested using a variety of statistical techniques culminating in the regression models presented in chapter 10. The initial model (figure 11.1) is refined by the results from the empirical study and the final model is presented in figure 11.2. Within this model, environmental attitude is the main determinant of green supply chain management practices, with a small influence from the intensity of external legislative pressures. These relationships are moderated by size (SME versus large organisations), but only to a small extent. This final regression model is mirrored by the findings from additional regression models when the organisational contingencies are controlled (table 10.12). In some instances the legislative or size variables become less influential and are not significant at $p<0.01$, but remain significant at $p<0.05$. Environmental attitude remains the dominant explanatory variable within these additional regression models.

11.3 Contribution to the field

This thesis develops an integrative model of supply chain management examining the influence of a range of external variables (legislative, competitive, societal and supply chain) and internal factors (internal drivers, environmental attitude, internal and supplier obstacles) on the adoption of green supply chain management practices and tests this model empirically. This research contributes to the field of green supply chain management in a

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significant at $p<0.01$ (Spearman rho value = 0.463) number of important ways as detailed within this section.

- *Presents a summary and analysis of the influential prior research studies in aspects of green supply chain management*

A limited number of studies (such as Carter and Ellram 1998) present a literature review of the influential studies into aspects of green supply chain management. Few of these examine both upstream and downstream activities, and none of these systematically evaluate the literature in this area, in the manner adopted in this thesis as presented in appendix 1.1 and table 1.1. The evaluation of the green supply chain management literature, and its assimilation into the green supply chain management model, is a clear contribution to the advancement of the green supply chain management research agenda.

- *The analysis of research gaps in aspects of green supply chain management*[2]

Whilst there are a number of general criticisms levied against green supply chain management research, only the paper by Carter and Ellram (1998) provides a review of a body of green supply chain literature (in that case reverse logistics) and the key research gaps in each paper. In this thesis, the review and evaluation of research gaps in the green supply chain literature is much wider than anything that has been currently presented to date. In particular, the overview of research gaps in green supply chain management presented in appendix 1.2, and discussed in section 1.3, is a significant contribution to knowledge.

- *Validation of the measure of environmental attitude developed by Murphy et al. (1996)*

The development of the measure of environmental attitude based on the protocols established by Murphy *et al.* (1996) is presented initially in section

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[2] Table 1.2 summarises where the research gaps identified by previous authors, (summarised in the literature critique in section 1.3 and appendix 1.2), are located and indicate the more general contributions to research presented in this study.

3.3.2.2 and section 8.4. A direct comparison between the environmental attitudinal typology of Murphy *et al.* (1996) and the green supply chain management practices of the respondents to this study is presented in section 9.5.2. This thesis presents the first re-examination of this influential reverse logistics study across the whole of the supply chain and outside of the geographical and sectoral boundaries of the original work. No other studies have re-examined the protocols used by Murphy *et al.* (1996) to measure environmental attitude and as such this thesis provides a significant contribution to the debate regarding 'environmental attitude' and the validation of the Murphy *et al.* (1996) protocols.

- *Presents the first systematic examination of outreach activities by companies to suppliers and general industrial networks as part of green supply chain management*

This thesis also examines the role of outreach activities such as supplier education, or membership of industrial networks as presented in section 9.3.1.5 and 9.3.1.6. These elements have previously been badly represented in green supply chain management research, especially with the main focus of supplier interaction being on elements of assessment and evaluation. Whilst, some papers have advocated a partnership approach and networking as important to the success of environmental management (such as Holt *et al.* 2000), this thesis presents the first empirical investigation of the influence of such outreach activities on actual green supply chain management practices.

- *Presentation of an empirically tested model of green supply chain management practices and the influence of external drivers and internal factors.*

The main contribution of this thesis is the development and empirical testing of a model of green supply chain management, which addresses the main criticisms of previous studies as identified in the literature (see section 1.3) to:

- develop a theoretical framework of green supply chain management based on previous research (after Carter and Ellram 1998);
- use a study that goes beyond one supply chain or a single organisations

(after Wu and Dunn 1995);

- adopt a systematic, holistic research approach, which includes logistics and purchasing (after Beamon 1999; Hutchinson 1998; Wu and Dunn 1995; and van Hoek 1999); and
- focus on empirical rather than anecdotal research (after Carter and Carter 1998; Carter and Ellram 1998; and Zsidisin and Siferd 2001).

In particular, this model presents the first example of its kind using empirical techniques to support the influence of environmental attitude and legislative drivers in determining actual levels of green supply chain management practices.

The examination of this model also provides a clear contribution to knowledge in terms of the influence of organisational contingencies upon green supply chain management practices. Whilst anecdotal examples have been previously presented of various 'types' of organisations being more likely to engage in green supply chain management, this thesis advances this debate by presenting clear empirical support for the influence of size upon engagement in such activities.

11.4 Contribution to practices

The nature of most previous green supply chain management research is exploratory. The lack of comparability between this empirical, cross-sectoral, whole supply chain study and those that address only purchasing or logistics, or use anecdotal examples results in a number of ad-hoc comparative findings regarding individual constructs in the model (as presented in chapters 7, 8 and 9). However, the main contribution of this research in this study is the empirical validation of a green supply chain pressure/ response model. Whilst much has been written on external drivers, and anecdotal examples of specific actions no study, until this one, has explored the empirical link between such pressures, environmental attitude and *actual* green supply chain management practices across the whole of the supply chain.

It is clear from this study that there are specific triggers that determine green supply chain management activity and the major trigger appears to be the internal environmental culture of the organisation, to a lesser extent environmental legislation with the moderating effect of size. Understanding what factors triggers actual green supply chain management practices is a key requirement of the effective targeting of government policy initiatives, to make green supply chain management an effective market mechanism for truly cascading improved environmental behaviour through a supply chain, and ultimately the whole of the business environment.

As organisations, especially multinationals, increasingly use green supply chain management to improve their own and suppliers' environmental performance, understanding what green supply chain management is in practice, and what triggers it, is an important consideration for businesses. It is hoped that this study will facilitate the use, and development, of green supply chain initiative in members of the CIPS and by other managers. Specifically this study allows managers to identify:

- A range of practical activities that constitute green supply chain management practices across the whole of the supply chain;
- To benchmark themselves in terms of this activity relative to their peer group and others through assessment of the operational status as laggard, high/low average or proactive;
- To benchmark their environmental attitude in terms of their designation as moderate, conservative, progressive; and
- To understand in more detail some of the limiting factors that may be affecting a supplier's ability to make changes in their environmental performance in response to their requests;

The overwhelming influence of internal environmental 'attitude' and legislation suggests that a push/pull approach is necessary. Firstly, that organisations are 'pushed' to make changes in their environmental behaviour through actual environmental legislation or the threat of future legislation. Secondly that changing environmental attitudes through education, internal initiatives, reward schemes and employee involvement may be influential in driving forward such initiatives. Future work that examines what it is about progressive organisations that make them progressive in 'attitude' would be advised to focus on these internal factors as enabling influences in the development of a green supply chain.

The policy implications of this study are important to note. What is clear is that the influence of the 'supply chain' is not a dominant factor, calling into question the effectiveness of voluntary mechanisms to green the supply chain through the green 'multiplier' effect. The influence of the internal environmental attitude of the organisation suggests that focus on the internal enabling factors that promote environmental behaviour and change environmental attitude/culture of an organisation may be a fruitful avenue to explore. The lack of outreach activities suggests that many 'mainstream' organisations are failing to engage with their suppliers, governmental or business support groups that facilitate environmental management.

11.5 Limitations

A model is a parsimonious representation of reality. Furthermore it is bounded by what is true at the time, and the fundamental assumptions made when theorising such models reflect the conditions and circumstances of the respondents at that point in time. Such assumptions reflect the closest approximation the researcher can achieve to complete knowledge and understanding of a situation. However, whilst it is impossible to fully capture all factors affecting the behaviour of organisations, such models represent a simplification of the complexities of organisational reality. The use of triangulation in the research methods adopted, thorough analysis of previous literature and a rigorous methodology, seeks to make the fundamental assumptions made in the green supply chain management model as close to an approximation of this organisational reality as possible.

The green supply chain management model also uses numerical scale variables to test the relationships identified within it. Such scales are again 'simplifications' of reality and use multiple constructs to capture the diversity of each respondent's specific circumstances and responses. The adoption of single respondents in the data collection phase produces a form of common methods bias, whereby the inappropriate targeting of such respondents or their lack of attention when completing the survey may lead to incorrect answers. Section 5.3.2 examines in more detail the mechanisms employed in this study to carefully target the respondents and each response was visually checked to see if there were 'patterns' of responses that indicated lack of attention to detail. Section 5.6.4 explores in more detail the specific limitations associated with the methodological approach used in this study.

However, in addition to these limitations a number of other issues are not addressed in this study. As Handfield *et al.* (1997) states, cross-functional buy-in is identified in the previous literature as important in the integration of environmental strategies into supply chain management. Since this study did not examine 'paired' responses from each organisation, it is not possible to examine the relative role of different departments/ functions in each specific organisation and this might be incorporated into future studies.

The lack of response from small and micro organisations (5.4%) is related to the composition of the database used in this study and the screening process adopted, as discussed in section 5.6.4. This inability to reach a large SME sample is a direct result of the specific nature of the database used, although it is possible to test the influence of size through designation of small/medium, large and very large as organisational contingencies. Thus, future work is still necessary on the applicability of this model to the smallest organisations and in particular, green supply chain management practices in micro businesses.

Where possible, the findings have been triangulated with those of previous studies, however it is often difficult to directly compare these. For example, the work of Murphy and Poist (2000) presents a descriptive overview of the green logistics practices of their respondents, but without reference to how their findings compare with others. Often such studies have a particular view / focus that also make comparison difficult, such as the focus by Murphy and

Poist on US versus non-US firms in logistics. Also some of the previous studies use factor scores for operational activity (such as Zsidisin and Hendrick, 1998) but do not present the descriptive findings of the constructs that make up these factors scores and this again makes direct comparison between constructs difficult. As such, using this study to 'unite' all the previous research in this area is not possible, and the comparative assessments presented in the findings in chapters 7, 8 and 9 tend to be somewhat ad-hoc in nature.

Preuss (2001) notes that adverse trading conditions appear to lead to a decrease in the importance of environmental issues in organisations, yet this study did not examine the specific trading conditions of the organisations in the sample and the turnover data was not used as it was not consistent amongst all the respondents.

The influence of sector appears insignificant in this study but direct comparison using SIC codes between this study and others is not possible. The sectoral groups used in this study are very broad and do not distinguish for instance, between light and heavy manufacturing. A more detailed breakdown of sectoral composition might have provided further insights to the possible moderating influence of sub-sectoral groupings.

The influence of perceived environmental risk and impact appears influential in moderating individual variables in the green supply chain management model but are not significant in the final model. One limitation to these measures is the lack of uniformity between them (discussed in section 6.5) although it could be argued that perceptions of risk/impact are valid measures in their own right. Future studies could seek to triangulate these measures with publicly available data or the use of descriptive definitions that respondents choose from.

11.6 Suggestions for future research

The overwhelming influence of environmental attitude as a determinant of green supply chain management behaviour suggests a clear agenda for future research. Such research should examine the specific internal differences between the environmentally progressive organisations (most operationally proactive) and the conservatives (least operationally active). A comparison of the internal enabling organisational factors, or actors, that result in a strong internal environmental attitude and proactive level of green supply chain management practices is an important aspect to consider in future research. In this type of exploration a case study based approach that examines in detail examples from the three different environmental attitudinal groups would be needed to build the theoretical constructs, followed by empirical examination. Such a study would need to examine which influences/characteristics can be identified that result in a paradigm change from conservative to moderate and to progressive.

The final regression model developed in this study should be examined in a larger study that has more cases in different sectoral classes. This would allow the validity of the model to be assessed in different settings. Likewise, examination of the model in different cultural/ national settings is important, for instance in the USA, Asia and Europe. Nationality of the organisations in the sample is not explored in the green supply chain management model, but is explored in section 6.7. The non-UK group has higher levels of environmental pressure but this is not translated into higher levels of green supply chain management activity. This suggests that the influence of nationality should be explored further in future studies using larger non-UK comparative samples.

Section 10.6 explores other influential studies that model aspects of green supply chain management but none specifically examine the influence of the moderating effect of organisational contingencies on the relationships in the models. This suggests that future research should expand on this theme and specifically incorporate such contingencies into the empirically testing of green supply chain management models.

11.7 Reflection on the thesis

When you reflect back on the journey undertaken when completing a PhD thesis it is easy to retrospectively identify aspects of the research process you could have improved or undertaken more efficiently. Many of the changes I would have made are encapsulated in the comments I have made regarding the limitations to this study and revolve mainly around the difficultly of gaining access to a large sample size and additional measures that might have been used to assess business conditions and levels of risk and impact. However every research project identifies small aspects that might have been addressed differently, as this is an integral part of the research process. What is more important in my mind are the many lessons I have learnt during this process that I take with me into my future research career.

Learning about the process of research, has brought a level of rigour to my research that I could not have gained without undertaking the PhD process. For instance, the necessity to spend significant amounts of time thoroughly researching a topic and the tools that can be used to facilitate the analysis of large amounts of information. Prior to undertaking this study I was less experienced in quantitative data collection techniques and this process has significantly advanced my understanding, and appreciation of these. One area that I intend to explore with future research on green supply chain management is that of structural equation modelling. Because of the embryonic nature of research in this field it was not possible to develop both an integrative, empirically tested model of green supply chain management and also move this on to the next level in terms of structural equation models within the boundaries of this thesis, and the size and composition of the sample used. As the empirically findings emerged, and the influence of environmental attitude became clear, I would have liked to have incorporated additional measures into my research instrument to further explore the importance of this variable. But again this remains an interesting future area of enquiry that will allow me to build upon the work in this thesis.

I chose this topic due to personal and professional interests in environmental management. Since beginning this work I have met many of the authors whose work I have reviewed for my study and their reception to it has led to a number of fruitful collaborations that would not have been possible without undertaking this particular topic. I have also gained a great deal of satisfaction from being able to add to the body of knowledge on such an important topic. Ultimately if organisations are to fully engage in environmentally responsible behaviour, studies like this one are crucially important in determining which factors may promote such behaviour.

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The Development and Empirical Testing of a Pressure/ Response Model of Green Supply Chain Management amongst a cross-sectoral sample of members of The Chartered Institute of Purchasing and Supply

Volume II

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APPENDIX 1: OVERVIEW OF KEY LITERATURE ON ASPECTS OF GREEN SUPPLY CHAIN MANAGEMENT AND CORPORATE ENVIRONMENTALISM

Appendix 1.1: An overview of influential prior studies in green supply chain management and some associated studies on corporate environmentalism

Key to Focus: P- Upstream focus L- Downstream Focus S – Across Supply Chain RL – Reverse Logistics O – Other

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
2004	Carter and Jennings	P	Examines the role of purchasing in CSR (PSR) using structural equation models	First study to define and empirically examine dimensions of PSR. Areas of diversity, environment, safety, human rights and philanthropy full under PSR	Recommends cross cultural comparisons, liability and threat of future action, longitudinal studies	Sample of US firms in consumer products manufacturing industries (members of ISM) and SIC codes 20, 23, 28, 36, 39 (n =201) 21.5% response rate
2004	Ellram *et al.*	S	Examines the simultaneous design of product process and supply chain known as 3DCE	Reviews the area of 3DCE and develops series of propositions linking 3DCE and sustainable network development	Propositions need testing	Theory development
2003	Banerjee *et al.*	O	Examines the antecedents to corporate environmentalism and the influence of industry type, with specific reference to marketing	Provides empirical support for relationships between various antecedents and corporate environmentalism and the existence of the moderating effect of industry type	Examination of other organisational characteristics recommended and interaction between antecedents	Cross sectoral survey in USA (n=29) response rate 32.8%
2003	Murphy and Poist	L	Compares US and non-US firms in respect to their environmental issues, practices and strategies in green logistics	Overall found similar results between the US and non-US sample with respect to practices concerning management of green issues in logistics. US and non-US firms had different perceptions on nature of policies for managing the environment	Recommends more spatially based research. Paper is unclear as to the chronology of the research and time of data collection from different samples	Same data set as Murphy and Poist 2000
2003	Nagel	S	Focus on the management of environmental performance of production facility in the electronics industry Uses an environmental performance tool to benchmark 25 US, European Canadian and Asian	Paper examines aspects of environmental performance and criteria that can be used to assess this. Suppliers informed that the tools would be used to classify the production facilities and failure to respond would result in negative classification. Allows supplier classification, ranking	Of the 25 firms 3 classed as bad and 22 as very bad. Further evaluation of why this performance is so poor needed. Only 9 companies had an understanding of their mass balance and this needs further investigation	OEM provided contact names and facilities received introductory letter. 5 weeks later floppy disk with electronic evaluation tool sent. Further 7 week period where environmental consultants available to assist

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
			printed board production facilities	and evaluation relative to each other		companies
2002	*Boons*	S	Presents a conceptual framework of six types of product chain management from perspective of product stewardship.	Examines categories of costs and benefits for suppliers, producers, distributors and consumers and examines their differential nature. Examines strategies each of these actors can employ	Needs empirical testing. Paper identifies further research needs as examination of: Product chain as a series of actors. Options available to reduce ecological impacts of products. Assumptions regarding the behaviour of actors in the product chain	Uses literature review to develop theory – the framework of product chain management
2002	Carter and Jennings	P	Examines the potential impact that purchasing social responsibility might have on supply chain relationships	Purchasing Social Responsibility has a direct and positive impact on supplier performance as well as an indirect effect through improved trust and co-operation. Scale variable developed to measure environmental purchasing from 6 constructs.	First empirical survey to test this relationship – requires further testing and comparison with other countries.	US based survey to 1000 purchasing managers and executives in consumer products manufacturing industries 201 returns (21.5% response rate)
2002	De Bakker and Nijhof	O	Draws on stakeholder theory and literature on the resource-based view of the firm and presents a framework for assessing the organisational capabilities of responding to claims from internal and external parties	Applies the framework to three cases of responsible chain management, as a tool for assessing organisational capabilities. Balance between internal and external capabilities on four levels: interpretation, integration, monitoring and communication	Current application firm specific. Future work suggested is to extend it to sectoral analysis. Could investigation differentiation on firm size or how to embed framework in a firm's strategy and operations	Applied to three current initiatives Social accountability in the textile industry. Product orientated environmental management. Tropical hardwork certification. Theory building
2002	De Bakker *et al.*	O	Describes and analyses organisational effects of product orientated environmental management from an individual firm's perspective	Examines two business units in a Chemical industry group (ResinMaker) to identify the organisational capabilities needed to develop product orientated chain management: creasing sufficient flexibility, broad involvement across functions and managerial ability to identify and build required capabilities.	Needs to examine a larger number of cases, and also examine firms developing product orientated environmental management – rather than best practice examples	Two cases studies from chemical industry
2002	Faruk *et al.*	S	Reports on research towards a pragmatic mean for analysing, mapping and managing environmental impacts along the supply chain.	Develops a management tool for ecological supply chain analysis. Aim of ecoscan tool is to link material flows with supply chain management in order to stimulate innovation in products, processes and management techniques. Focus on determining the absolute burden of products.	Further testing and replication	Tested ecoscan tool with case study as part of a pilot exercise in a major UK public service
2002	Hagekaar *et al.*	S	Paper examines use of LCAs to support escm	Argue that a differentiation between types of LCAs should be made; compliance process and market orientated LCAs. Chain structure should be attuned to meet specific requirements of each type and different types of LCAs bring about different chain structures	Needs replication using larger sample and perhaps empirical work	Uses two illustrative case studies (the slaughter by-product chain and coffee distribution chain). Theory development

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2002	New *et al.*	P, S	Examines the differences and similarities between private and public sectors regarding green supply, incorporation of environmental considerations into procurement and supply chain relations.	Detailed and analysis of description of differences between private and public procurement in organisations. Traces development of green supply ideas within organisations	Recommends care needs to be taken to avoid too easy generalisations when there are differences in sectors and individual abilities amongst purchasing managers.	Interviewed managers and purchasing staff, work as consultants and as a sounding board for manages, and ran an environmental supply chain form at which practitioners came along to report aspirations, confusions and progress. Private and public sector UK organisations (with a few overseas companies).
2002	Polgreen	S	Overview paper on social and environmental supply chain management	Synopsis of some of key issues and drivers	Needs empirical framework	Discussion paper
2002	Rao	S	Exploratory analysis investigating environmental initiatives undertaken by leading edge companies in green supply practices in South Asia.	Provides overview of greening the supply chain with specific reference to S. Asia	Expansion to larger sample and companies not classed as 'leading edge'	14001 certified companies in Philippines, Indonesia Malaysia, Thailand and Singapore. Empirical survey with 52 responses (10% response rate). Used Amos structural equation modelling to analyse data.
2001	Autry *et al.*	RL	This paper examines how reverse logistics performance and satisfaction is related to firm size, sales volume and internal and external assignation of responsibility for disposition. Focuses on RL programmes in the electronics industry, specifically those that sell through catalogues	Identifies that companies that identify themselves as successful in achieving regulatory compliance (5.69 mean on scale 1-7), and improving customer relations (mean = 5.66). Less successful were internally focused gaols such as recovery of assets, cost containment and reduced inventory investment. Identifies sales volume as significant factor in determining RL performance. Smaller firms appear to be performing RL better	Identified need for future work in measuring attitudes of trading partners, assessing different industries and assessing the impact of outsourcing on RL programmes performance and satisfaction	A literature review and interviews to design research instrument. Survey sent to 212 CEOs from a commercial mailing list of electronics firms that sell through catalogues in the USA. 71 useable surveys (a 33.5% response rate) using Likhert style questions. Average sales volume $32.3 million and average number of employees was 160.
2001	Berger *et al.*	S	Article critically reflects upon ecological modernization as a basis for current environmental policy and discourse and the implication of environmental supply chain management (escm)	Provides a critique of ecological modernization theory and details the implications of ecological modernization theory to supplier relationship in escm. Concludes by noting the role the economic imperative has more of a role than environmental issues and including into the business agenda when there is external legal or customer pressure. Issues of power and influence environmental policy and discourse.	More work needed on analysis of policy strategies to include environmental criteria into economic development. More research needed and more details on specific research methodology employed	Case study of a project on environmental partnering action for SMEs in industrial South Wales with large manufacturing firms. Exploratory initial findings in light of theory of ecological modernization and role in environmental policy making
2001a	Bowen *et al.*	P	Examines the green supply chain	Generates an operational typology from the data by	Needs replication. Large UK firms only	Data from a two-phase survey of 70

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			practices adopted by particular types of firms and performance implication	clustering respondentsPhase 1: Semi structured interviews with senior managers in 24 business units. Phase 2 involved mailing two questionnaires to (1) manager (2) purchasing officers. 138 sets mailed. 95 manager (69% response) and 70 purchasing (51%) returned		operating units in UK pubic limited companies.
2001 b	Bowen *et al.*	S	Examines role of supply chain management capabilities in green supply, arguing that implementation of green supply is better explained by focussing on internal resources than external pressures	Develops a predictive model of the role of management capabilities in green supply (scmc). H1, H3, H4, H5 supported. H1: There is a positive relationship between extent to which firm possesses appropriate scmc and implementation of product based green supply. H3: positive relationship between proactively of firm and extent to which firm possesses appropriate scmc. H4: positive relationship between strategic level of purchasing and supply and scmc. H5: positive relationship between proactively and likelihood of implementation of green supply	Suggest that further research addresses a larger sample, with a more normalised sampling framework	Same as Bowen *et al.* 2001 a
2001	Carter and Dresner	P	Develops series of propositions concerning the implementation of environmental projects	Used grounded case study interviews to develop a series of propositions of on purchasing's role in environmental management. Takes a functional approach	Propositions need testing in larger sample	Sample from firms with both successful and unsuccessful environmental projects (23 informants over 5 firms)
2001	Chapple *et al.*	O	Examines the characteristics and attributes of UK firms accrediting to ISO14001	Empirical study that analyses the actual characteristics of firms that accredit. Unique dataset of company accounts of all UK manufacturers signed up to ISO14001. Found very larger and smaller organisations more likely to accredit than those in mid size category. Found industries that have high levels of exports relative turnover more likely to have 14001	Could extend to other sectors and nationalities. Could be tested with other 'standards'	Analysed characteristics using discrete choice probit model with panel data. Control group of non-ISO registered from Fame database
2001	Elwood and Case	P	Examines the US government's environmentally preferable purchasing programme. Examines examples of private sector companies who are choosing to buy green and types of actions taken	Anecdotal and literature based overview of aspects of private companies' environmentally preferable type purchasing programmes.	Overview only, needs theory development	Descriptive paper using elements of cases of green purchasing
2001	Hall	S	Paper proposes a sphere of influence model describing why firms should	Argues large high profile films are under pressure from a wide range of stakeholders. Whilst smaller	Suggests trends could be emerging in other sectors – further testing of this	Four year long case study. Open interviews with senior managers in

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			invest in environmental supply chain innovation.	firms are under less pressure but highly influenced by demands of customers. Model tested on UK supermarket retailer Sainsbury's plc and 5 of their suppliers. Some comparison with work of Hall (2000).	required.	Sainsbury's and supplier firms. Also reviewed publications and formal company documents.
2001	Khoo *et al.*	S	Simulation of a supply chain distributing aluminium metal. Simulation and modelling tools used to aid decision making process of mode of transport and distance selections	Presents powerful tool for decision making and optimising decisions in developing the green supply chain from a logistics perspective	Needs further development particularly study of material ordering, production time and inventory control from supplier to end-user. Could apply similar approach to other material supply chains.	Simulation model
2001	Preuss	P, S	Discusses the idea of a green multiplier effect along the supply chain and role purchasing might play as an important agent of change regarding environmental initiatives	Did not find evidence of a multiplier effect – many claimed environment did not affect their organisation. Environmental issues emerged as a by-product in all cases rather than being pursued as objective in it's own right. Most prevalent motive was legislation, then cost efficiency and the positive market effect. Study isolated industry and product characteristics and product price bracket that seemed to support/prevent environmental initiatives. Only three industries of paper making, chemicals and electronics were found to have above average level of environmental initiatives	Further areas of research suggested on formally integrating environmental issues into purchasing decision making and involving purchasing manager in managerial decision making.	Sample amongst Scottish manufacturing companies - 40 companies approached 30 agreed to interviews (19 large, 8 medium and 3 small)
2001	Rodrigue *et al.*	L	Discussion of the use of the term green logistics as it applies to the transportation industry.	Provides good overview of development of green logistics and some of the practical elements	Descriptive review and discussion – needs theory building	Book chapter – overview
2001	Theyel	S	Explores the adoption of environmental supply chain relations in the US Chemical industry and the connection between the supply chain and environmental performance	Analysis suggests that a reciprocal learning process between customers and suppliers occurs as they exchange information. Firms that collaborate with customers tend to collaborate with suppliers and have the greatest success in waste reduction targets. 650 US plants in plastics/ resins and ink manufacture approached. (2 of the 17 sectors identified by the USA EPA with the greatest potential for improving environmental performance)	In depth research of firms across all industries needed to identify which are best suited to benefiting from closer supply chain relationships	Survey with 60 closed questions. Pretested on 6 plant managers and 6 environmental consultants. 188 returns (28.9% response rate). Follow up telephone and face to face interviews with 20 respondents
2001	Young and Kielkiewicz-Young	S	Presents an overview of current practices of managing sustainability issues in supply networks	Examines eight economic sectors in Europe and North America. Found for most integration of sustainability issues is a new area of activity and	More details on study characteristics needed in this paper and specific methodological approach	Survey followed by in-depth cases in 6 sectors (utilities, transport, ICT, Retail, Tourism and Leisure, Construction,

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				may yet to begin to manage them in supply chains. Mostly due to pressure of external driver. Current edge companies are exploring partnership approaches for sharing knowledge and joint problem solving		chemicals and public sector
2001	Zhu and Geng	P	Green purchasing in large and medium state owned enterprises in China (LMSOEs)	First study of kind in that region. Adapts work of Min and Galle (1997) and Watson *et al.* (1998) to look at Chinese context. Found close buyer supplier relationships led to reduced numbers of suppliers	Only reports mean rank scores for data, more in-depth statistical analysis needed	Survey (302 responses) a 60.4% response rate, 28 further interviews at LMSOEs
2001	Zsidisin and Siferd	P	Review and synthesis of some of common themes in environmental purchasing literature and proposes a theoretical direction for future research	Defines ESCM and environmental purchasing. Examine some of the research studies across the supply chain and highlights some of the questions this research raises	Test recommended future research directions, such as event history analysis of environmental adaptations, integrating theory into purchasing studies, examining in more detail supply chain partnerships	Theory development and literature review
2000	Carter *et al.*	P	Uses data from survey reported in Carter and Carter (1998) to examine the effect of environmental purchasing on firm performance	Survey and archival data shows that environmental purchasing is significantly related to both net income and cost of goods sold after controlling for firm size, leverage and primary earnings per share	As Carter & Carter 1998	As Carter & Carter 1998
2000	Fleischmann *et al.*	L	Characterises logistics networks for product recovery	Review's nine examples of models of logistics recovery networks from the published literature. Characterises and classifies product recover networks. Builds on the quantitative models presented in the 1997 work. Identifies network types as reusable item, remanufacturing and recycling with individual characteristics in each one	Recommends more mathematical modelling, more detailed analysis of the aspects characterising different network types. Needs examination in light of other case examples	Theory building/ analysis of case studies that have been published in the literature with quantitative models
2000	Geffen and Rothenberg	S	Examines the role of partnerships between suppliers and OEMs in the US automotive paint processes industry	Finds strong partnerships with suppliers, supported by appropriate incentives, were significant element of the successful application of innovative environmental technologies. Supplier staff members were an important component. Management factors influencing extent and nature of supplier involvement were identified.	Single sector, US based. Needs replication on a wider scale	Case studies of three plants, in the US. Taped and analysed interviews
2000	Green *et al.*	S, P	Discussion of the interplay between concepts of individual consumers and concept of the organisational consumer.	Article argues traditional image of consumer is inadequate, especially for considering the environmental challenge of greening industry. Argues should treat organisations as consumers	More academic work needed on how organisations operate in context of changing environmental pressures from suppliers and customers. More empirical	Discursive paper that examines published literature – theory building

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				and develops an approach for examining the differences and similarities between industrial and individual consumers	studies of the macro and micro processes involved in greening organisational consumption	
2000	Hall	P, S	Investigates the circumstances under which environmental supply chain dynamics (ESCD) emerge, involving the diffusion of environmental innovations diffuse from customer to supplier.	Proposes circumstances under which ESCD occurs. Examines diffusion of innovation, through overt pressure as well as voluntary uptake. Primarily focuses on the upstream process from customer to supplier	Small sample size, theory development requiring further validation. Needs expanding to consider cascade effect to second tier	Explanatory case study using four case studies based in UK or Japan conducted via open interviews. Us and Japanese supermarket chain, UK aerospace industry, Japanese convenience store group)
2000	Murphy and Poist	L	Research questions focussed on: The least and most popular environmental strategies in logistics for dealing with environmental issues The relationship between company characteristics and the strategies used.	Multinational study that identified recycling materials, reducing consumption and reusing materials to be the most commonly held environmental strategies used in logistics. Unexpected similarity between non US sample and US respondents	An applied, micro level survey. Recommendations include more empirical and theoretical validation. The limitations include the small size of the EU and Canadian samples. More in-depth analysis of various logistics strategies needed. Expand to include more macro level studies that look at relationship with public policy. Sample squewed towards larger firms.	Appears to used data from the Murphy *et al.* (1994) study on US firms (n=133) with the addition of data on 31 Canadian firms (response rate 24.6%) and 24 EU firms (Response rate = 24.7%). Contacted via the membership of the Council of Logistics.
2000	Ritchie *et al.*	S, RL	Describes research project carried out within Manchester Royal Infirmary to evaluated improvements in the recycling and disposal of pharmaceutical products	Argues that there are significant financial and operational advantages to the NHS and other organisations in developing reverse logistics systems	Needs developing into theoretical constructs. Focus is on transportation.	Analysis of returned stock from 28 hospital units over two weeks.
2000	Young	L	Examines residual disposition (and reverse logistics) in five case study organisations	Firms generate residuals at multiple functional points preceding manufacturing and disposition decision making is affected by intrinsic value, overwhelming volume of material and regulatory compliance.	Original data generated in 1992. Needs more recent examination. Further exploration of the role of waste exchange	Case studies in firms in furniture, commercial printing, electronics, and pharmaceuticals (presumably US based)
1999	Anderson *et al.*	L	Examines the Producer Responsibility Obligations (Packaging) in light of logistics operations	Discusses how reverse logistics systems can handle packaging waste and key role of logisticians	Needs conceptual framework and quantitative research	Telephone interviews with 10 companies (30 minutes). Five detailed case studies. Meeting with industry and logistics experts
1999	Beamon	S	Literature based and discusses the extended environmental supply chain (eesc).	Investigates the environmental factors leading to the development of eesc. Describes differences between eesc and traditional supply chain and the additional challenges faced by this. Details appropriate performance measurements. Develops	Some limited theory building – mainly an overview of current literature to provide a useful overview synopsis. Theory validation needed and reference to critically reviewed research.	Literature overview to provide synopsis.

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				a general procedure towards achieving and maintaining a green supply chain		
1999	Gungor and Gupta	RL, L	Paper presents an overview of literature in the field of environmentally conscious management and product recovery	Provides detailed summary of literature in this field	Identifies further research needed on qualitative and quantitative decision tools for environmentally conscious manufacturing. Need to develop research that is interdisciplinary and looks at the interactions between the current 'clusters' of research being undertaken.	Theory building
1999	Jayaraman *et al.*	RL	Programming model of the location of remanufacturing/ distribution facilities, transhipment, production and stocking of the optimal quantities of remanufactured products and cores	Discusses use of model for managerial logistical decision making	Needs investigation of potential benefits of managerial actions to reduce uncertainly in return flows and practicality of such programmes	Grounds data using analysis of information from an unidentified manufacturing company with limited number of remanufacturing sites in North America and actively remanufactures a small electronic product
1999	Klassen and Whybark	O	Explores under what conditions investment in environmental technologies offers both environmental and manufacturing benefits	Grounded in resource-based view of the firm. Significantly better manufacturing performance found in those plants where environmental technology investment directed at pollution prevention, Similar results for cost, speed and flexibility performance. Emphasises pragmatic attractiveness of sustainable development	Used single industry. Suggests examination of intrafirm differences, exploration of integration of development of pollution prevention technologies with other technological and organisational strategic resources. Modelling of influence of external factors needed	Relationship between composition of environmental technology portfolio and plant level performance tested with survey and matched archival data. Examined US furniture industry. Major industry association hosted small focus group. Personal interviews with mangers in seven plants belonging to five firms. Survey sent to manufacturing plants in US with more than 50 employees from US EPA database. Sample of 302, received 83 responses (27.5% response rate). Incomplete answers led to use of 66-69 surveys
1999	Krikke *et al.*	RL	Examines the recycling of PC monitors at Roteb (the municipal waste management company of Rotterdam) in the Netherlands by presenting an optimisation model	Models recovery strategies and identifies future areas for research. Identifies that using the recycling optimisation models can reduce costs by 25% and suggests additional savings up to 40%	Needs replication. Further work on forecasting, extension of the modelling strategies with flexible disassembly sequences related to variety of criteria and sub-aspects of product recovery such as product design, financing of	Disassembled 119 monitors to provide data on composition, disassembly times and classification.

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					strategic alliances in recovery strategies.	
1999	Lamming *et al.*	S	Discusses concept of environmental soundness and sustainability	Paper argues that concepts of sustainable development may only be applied at global level. Therefore sustainably developed companies or industrial sectors not a practical objective. Proposes arguments for environmental soundness but against the idea of companies trying to move beyond this into social elements that are demanded by environmental sustainability.	Discussion paper - needs concrete examples of environmental soundness versus sustainability. Theory testing required	Discussion based theoretical paper
1999	Lippmann	S	Reports on the findings of the BSREF benchmarking study in supply chain environmental management.	Identifies actions of leading edge companies in survey conducted by BSREF. Identifies characteristics of most effective programmes as top-level leadership; cross-functional integration; effective communication with companies and suppliers; effective processes for targeting, evaluating, selecting and working with suppliers.	Descriptive analysis of 'leading edge' companies therefore not representative of all companies. Needs extension into larger sample	Descriptive analysis of leading edge companies in BSREF study (20 large multinationals with strong environmental remit)
1999	Nagel and Meyer	RL	End of life aspects of products, particularly IT	Develops a new approach for systematically modelling end - of - life networks. Discusses real life networks examples	Testing and replication	Modelling, case examples, theory building
1999	New *et al*	P	Discussion of the relationship between environmental controversy, innovation and competitive response of firms	Examines case of Baxter Healthcare who received a request for information on use of PVC in their products by a National Health Trust. Incident reported is symptomatic of pockets of environmental interest. Discussion of how simplistic arguments of customer pressure do not reflect the complexity of what was happening in this case	More examination needed of the context dependant mechanisms at work in green purchasing.	Uses interviews, observations of practice, primary and secondary data sources. Also draws on material from other national contexts and Baxter's relationships with suppliers
1999	Van Hoek	S	Overview of green supply chains and categorisation of green approaches.	Proposes that a focus on the entire supply chain rather than just reverse logistics and regulatory compliance is necessary. Stresses need for cross company dimension. Draws on the ecological footprinting theory	Requires empirical testing of ideas posed.	Research note, discussion
1999	Wycherley	P	Examines Body Shop International's (BSI) efforts in encouraging suppliers to improve their environmental performance.	Discussion of barriers and facilitators of environmental management amongst BSI suppliers. Found BSI requirements for product specifications are clear but there was no overt pressure to improve performance (discuses influence of the messages from BSI as a perceived leading edge company)	Further investigation of networks such as the Better Business Forum and other similar networks	Case approach. Initial meeting with ethics department. A sample of 20 suppliers selected (16 resale suppliers and 4 suppliers for internal operations) Semi structured Interviews

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1999	Ytterhus *et al.*	S	Present the results from the Business Environmental Barometer project	Discussion of multiplier effect and role of quality management in environmental management. Example of partnership building in supply chains using fresh produce as an example. Comprising a family of survey conducted in Nordic countries and later Europe over 4 year period in retailing sector	More investigation of benefits of partnering approach needed	Survey discussed was from 1244 Norwegian service companies in 1996 with a 33% response rate
1998	Barros *et al.*	L, RL	Examines a sand recycling network in the Netherlands	Proposes a two level location model for the sand problem and consider its optimisation using heuristic properties. Identifies in the importance of location theory in recycling and waste management	Needs testing and replication	Modelling of logistic networks, Theory Building, Case example
1998a	Baylis *et al.*	P	Book chapter that explores implication of greener purchasing for SMEs	Report on survey research. Literature review identified barriers for SMEs. Survey found that SMEs received more assistance from their suppliers than their customers. That SMEs were not always below a larger company in a supply chain with implications for channel power. More pressure was felt by larger firms than SMEs.	More investigation of the role of SMEs in green supply chains is needed. Survey was based in one geographical region and not cross sectoral	Survey questionnaire sent to 914 manufacturing and processing firms in South Wales. 216 SME responses and 204 large companies equating to 46% response rate. 42 questions sent in survey. Followed by site tours and interviews with 25 SMEs
1998	Canning and Hanmer-Lloyd	P	Details results and managerial implications of environmental adaptations in the supplier-customer relationships in 4 case study business to business firms	Presents an overview of four inter-firm relationships. Describes environmental adaptation processes. Identifies factors stimulating or hindering environmental adaptations. Adaptations occurred in the case studies to respond to elements of uncertainty (from environmental regulation or competitive market dynamics) and cost	Qualitative assessment of adaptive relationship needing further validation.	Descriptive qualitative study in four case study firms (telecom equipment supplier, cable supplier, plastics supplier and labels supplier) and in-depth interviews with 26 managers
1998	Carter and Carter	P	Developed and empirically tested model identifying how inter-organisational factors drive and constrain purchasing's involvement in environmental management.	Identified and tested six hypotheses. Study developed the construct of environmental purchasing in a more holistic manner than previous studies and included activities that included eco-efficiency principles	Provided an initial empirical test of environmental purchasing not a theory. 1995 survey Comparative studies required. Only set in consumer products industry.	US based Theory building, hypothesis testing, survey and structural equation modelling. n = 1083 (41.7% response rate). Model tested via survey responses to NAPM managers in consumer products manufacturing firms
1998	Carter and Ellram	RL	Provides a review of 15 articles on reverse logistics and identifies research gaps	Summary of literature to model the main environmental forces and a reverse logistics hierarchy. Provides a theoretical foundation for future work proposing a framework of the internal and external factors that impact the reverse logistics hierarchy. Government, suppliers, buyers and competitors see also Carter and Carter (2000)	To examine and test the theory models provided.	Review, Theory Building

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1998	Carter *et al.*	P	Compares environmental purchasing in US and German corporations	Authors present a scale to measure environmental purchasing, examine company specific factors that impact these activities and compare actions of US and German purchasing managers. German firms were significantly more involved in environmental purchasing than US companies	Confined to consumer manufacturing industry. More research needed on interactions between purchasing and other internal function. Study classed as exploratory and finding tentative –needs replication	Consumer products manufacturers. Construct and data used for US sample in Carter and Carter (1998). German sample from public list of 500 firms 125 returns from German sample (25.3% response rate) Questionnaire/model testing
1998	Davis	RL	Cutter Information Report: A synthesis of product stewardship using examples from the electronics industry	Provides a synthesis and overview of the state of product take back	Needs updating and linking to theory	Case examples
1998	Enarsson	S	Examination of supplier evaluation in association with four Swedish companies.	Proposes a method of evaluating suppliers environmental performance based in Ishikawa's fishbone diagram, based in excel so it can be used as an evaluative tool	Needs empirical testing	Not detailed in full – interviews with managers at the four companies.
1998	Gavaghan *et al.*	S	Discusses the USA based BSREF benchmarking project to examine the efforts if leading edge companies in greening their supply chains	Primary motivators are internal corporate values, customer interest and economic benefit. All were working with suppliers although differences in scope and scale. Identifies three approaches; comprehensive, integrated approach; targeted supplier effort; and industry standard approach. Extensive supplier management programmes share similar characteristics. All believed their actions had benefited supplies. All planned to continue programmes of gscm	Study focuses on leading edge companies with sales in excess of $100million per year, mostly large multinationals. Extension of this work to other countries, sector and sizes needed. Comparison of practices with other non' leading edge' organisations to see if these findings are applicable	Interviews with 20 companies and 19 stakeholder organisations and a review of publicly available information
1998	Green *et al.*	P,S	Examines the impact of green supply and purchasing on firms' environmental performance, using B&Q as case example	The collaborative partnership is not necessarily the most effective method for environmental improvement. Identifies two key research questions how green purchasing changes the performance of firms in a supply network; do such changes contribute to companies overall environmental performance and sustainability	Research needed on exact mechanisms inside firms by which environmental pressures are translated into action. Need to examine the extent to which customers in different sectors are involved in the drive to sustainability. Identifies need for performance measurement to see whether green initiatives actually make a concrete difference	Discussion paper, using single case example of B&Q
1998	Holt	S	Exploratory study examining whether organisations believed that they has benefited from accreditation to an	Measurable attributes associated with waste, water and energy management leading to cost savings appear to be apparent in companies surveyed.	Exploratory study only. Further research needed in: establishing the point at which financial benefits from	13 responses from organisations accredited to BS7750 (43% response rate). Survey

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			environmental standard	Some benefit seen in terms of marketing and image perception. None of respondents indicated a link between share price and gaining the standard but six indicated that award might have led directly or indirectly to improved profits. 47% believed award placed them in stronger position than competitors	environmental management cease and more altruistic reasons take over; how beneficial different parts of the company feel standard has been. More work needed on influence of size and sector	
1998	Johnson	RL P	Examines reverse logistics, and the influence of purchasing in the ferrous scrap of 12 US manufacturing plants	Purchasing plays a significant role in RL at the plants in the study. Volume was found to significantly influence strategy and processes used. Identifies 6 volume-based strategies. Presents an opportunity to study a RL network in place for economic reasons rather than environmental	Further examination of RL networks needed especially for the perspective of other functions rather than purchasing.	Case approach using theoretical sampling. 47 managers interviewed in 12 plants
1998	Klausner *et al.*	RL	Examines reuse of electrical motors in consumer products, with particular reference to use of electronic data log circuit that records data that allows decision making regarding reuse decisions	Develops model and applies to German power tool market to indicate potential cost savings potential	Identifies quantification of life cycle analysis of companies systems with and without such an electronic log. Needs more detailed analysis.	Applied generally to German Power tools market but without specifics.
1998	Polonsky *et al.*	P	Exploratory examination of environmentally responsible purchasing behaviour linkage in Australian organisations, by the their organisation's purchasing agent	Develops a model of paper purchasing behaviour based upon Drumwright's 1994 classifications of socially responsible buying by organisations. Focus on rebuy questions	Need empirical testing, validation, and extension to other sized organisations and product ranges. Also examination of cross cultural differences.	In-depth interviews with eleven purchasing agents of Australian firms in one city with more than 100 employees. Manufacturing (4), Utilities (3) govt/statutory body (3) communications (1) Exploratory case based study
1998	Sarkis	L	Investigates the use of environmentally conscious business practices (ecbp) and develops a strategic assessment tool using analytical network process technique.	Model links strategic and tactical decision that are used to evaluate various ecbp programmes and technology alternatives	Testing of the model in various scenarios needed. Other decision factors such as cost, flexibility and quality issues need to be incorporated	Theory building – uses an illustrative example to examine the model.
1998	Walton *et al.*	S	Research on role of suppliers in environmental management in the furniture industry to identify key trends and practices currently employed.	Qualitative study of five case studies, using interviews with managers opinions of role of supplier management, new product development, in bound logistics and purchasing in environmentally friendly practices in the supply chain. Designed interview protocol	Exploratory selected 'pro-active' firms only. Assessed opinions from customer perspective only	Five case studies using semi structured interviews, coded and analysed in a meta-matrix in USA furniture industry
1998	Zsidisin and Hendrick	P	Comparative study of the extent of involvement those purchasing	Gap analysis to compare extent of actual activity, importance and change of environmental issues to	Future research needed on how managerial involvement in supply chain	Survey, using Likert scale and analysed via factor analysis.

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			managers in the USA, UK and Germany have in environmental issues, versus the level they believe they should have.	desired levels	management effects environmental performance and role of culture.	Descriptive. Survey sent to 599 sample in Germany (57 responses), 400 in UK (50 responses) and 400 in USA (93 responses) with an overall response rate of 14.3%.
1997	Fleischmann *et al.*	L, RL	Surveys the field of reverse logistics	Mathematical models and implications for reuse, efforts are provided in distribution planning, inventory control and production planning	Needs testing	Theory building
1997	Hill	S	Examines the importance of the supply chain as a source of environmental pressure on manufacturing firms in Yorkshire and Humberside	How and why a variety of firms respond to environmental pressure. Argues that customers leverage more pressure on suppliers. Environmental legislation identified as most important pressure.	Aim was to provide detailed overview rather than quantitative measures. Theory building paper that requires theory testing and replication, in other geographical areas.	Postal questionnaire (1991) sent to 1500 firms in most important manufacturing sectors in Yorkshire and Humberside, 301 returns 20% response rate. Followed by 30 in depth interviews from 3 different sectors
1997	Min and Galle	P	Assessed green purchasing strategies amongst a selection of member of NAPM who were involved in purchasing for industry groups that are heavy producers of scrap and waste materials Particular emphasis on packaging	A primarily large firm study that identified the key factors that affected a buying firm's choice of suppliers, source reduction within the operations function as a result of packaging decisions and obstacles to effective green purchasing.	Needs comparative work, sectoral and size analysis and retesting	US based Survey, analysed via SPSS, n = 527 (17.6% response rate)
1997	Noci	S	Designs a conceptual approach that identifies measures for assessing supplier's environmental performance and suggest techniques for supplier selection processes based on environmental criteria	Reviews types of supplier selection models	Needs testing	Theory building
1997	Wolters *et al.*	S	Examines the concept of integrated chain management (ICM). States this is a more holistic focus and goal than more limited supply chain initiatives.	Identifies four main areas that are stepping stones to ICM • Total Quality Management • Addressing business opportunities • Knowing relevant external environmental issues • Importance of environmental management systems	Needs theoretical development and testing	Discussion paper
1996	Elliott *et al.*	O	Examines motives for and against using environmental audits and	Compared by size and industry sector. Found mostly it was large (100+) firms that used an	Could be replicated in different geographical areas or sectors	Survey of firms in East Midlands from 8 SIC classes (n=-129) 32% response

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
			reviews	environmental audit and those with a highly visible impact		rate
1996	Florida	S	Examines the relationship between advanced production practices and innovative approaches to environmentally conscious manufacturing	Hypothesis presented is that firms are innovative and adopt advanced manufacturing practices and simultaneously realise improvements in productivity and environmental performance. Key findings: firms are leveraging their industrial modernization strategies for environmental ends. There is a close relationship between green design and R&D spending, product innovation and a range of advanced manufacturing practices. Factors associated with industrial performance are important, such as customer demands and productivity improvements. Close relationship across the production chain and between end users and suppliers facilitate the adoption of advanced manufacturing processes.	Primarily US based. Study was undertaken pre 1996 and therefore could be re-examined to see where these firms are now and replicated in other country settings. Examination of cultural difference between Japanese affiliated sample and US sample	Research survey faxed to 423 firms from the Standard and Poor listing in manufacturing sector. 256 returns (60.5% returns). Also draws on survey of 1500 Japanese affiliated firms (n=1195) and a control group of US suppliers to the automotive transplants (n=338). Phone interviews and field research used to collect more detailed information, using modified Delphi technique to identify from expert panel 39 candidate firms, with 18 agreeing to take part
1996	Garrod and Chadwick	O	Environmental pressure and response through business strategy	Examines SMEs in South Wales to examine their environmental management activities. Found low level of strategic importance and that regulatory stakeholders were most influential	Very small sample set – needs replication	Survey amongst SMEs (n =26) 15% response rate. Questionnaire included 18 detailed questions, including open and semi structured
1996	Green *et al.*	S, P	Explores the mechanisms by which environmentally informed business practises and technology may diffuse through industry	Analyses the results of some UK companies' practice in using their purchasing policies to green supply chains	Three themes of future research suggested- examine differences in supply chain structure and inter-corporate power; parallels between quality and process improvements initiatives; exact mechanisms in firms by which environmental signals in purchasing policies are understood by other functional areas. Exploratory. Not empirically tested	An interview with managers of six large firms in the UK, and a further nine that supply these companies. Selected cases through professional contacts (privatised utility, automotive manufacturer, scientific and engineering services, electricity supply, healthcare products manufacturing, electronics equipment)
1996	Groundwork	P	A guidebook to assist local authorities to integrate environmental concerns into purchasing practices	Overview for local authorities of drivers, what actions they can take and what some local authorities are doing. Appendix details the B&Q supplier assessment questionnaire	Descriptive guidebook – needs to be linked with research studies. Analysis of current practice in local authorities needed	Descriptive overview
1996	Hass	P, S	Case study of the development of new packaging in a hosiery manufacturer (UK)	Modelled the integration of different actors along the supply chain	Needs further theory development and replication	Case study, grounded theory, development of generic models

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
1996	IHEI	P	Provides green purchasing guidelines for hotels	Descriptive summary of options	Descriptive guidelines only	Descriptive summary, small case examples of current programmes
1996	Klassen and McLaughlin	S	Proposes a theoretical model that links strong environmental performance to improved perceived financial performance	Linkage of firms performance is tested empirically using financial events methodology and archival data of firm level environmental and financial performance	Suggests need to attempt to estimate the difference between market valuation of a crisis and clean up costs. More work needed on defining environmental performance as a measurable variable. Need to quality more exactly benefits of strong environmental performance for manufacturers under a variety of circumstances	Theory building. Model used citation references of 140 observable environmental award events – covering 96 publicly traded firms. 745 citations found referring to environmental crisis's – referring to 16 firms
1996	Lamming and Hampson	S	Examines the environmental issues for purchasing and supply chain managers. Develops the concepts associated with green supply and examines in light of 5 interviews with UK companies	Provides a review of vendor management practices and the concepts associated with green supply (but mainly green purchasing) which are examined in light of interviews	Exploratory study. Detailed list of questions regarding issues in product stewardship, waste streams, packaging, logistics, role of standards and whole life costing proposed that could be examined further.	Literature review, Five discursive interviews with managers of large or very large UK based firms with stated commitment to the environment.
1996	Lober	S	Examines criteria that might be used to measure a companies environmental performance and how these criteria might be organised	Overview of environmental management in organisations and development of detailed operational checklist of 'green' activities	Needs testing. Does not suggest how each criteria would be measured in practice	Theory Building only
1996	Murphy *et al.*	L	Investigates environmental issues in logistics from the perspective of environmental attitude defined as progressives, moderates and conservative firms.	Environmentally progressive firms were generally larger. Of the 11 environmental issues examined the progressives consistently identified these issues as being more important than moderates or conservatives did. The environmental progressives were more likely to undertake the 12 environmental strategies identified Pinpoints the major differences between the most and least active firms, which have implications for benchmarking. Provides practitioners with a method for quickly and easily assessing the current environmental status of their respective firms.	Needs replication. Needs testing in other contexts and cultural settings	Classified respondents based on 7 questions and gave them an aggregate score, Used Duncan multiple range test and ANOVA. Used data detailed in Murphy *et al.* (1994)
1996	Prendergast and Pitt	L	Discusses the trade off between packaging and logistics, marketing and environmental issues.	Examines who influences sales packaging decisions and whether these individuals perceive any trade off between marketing/logistics function and increased environmental demands. Found	Focus on sales packaging and views of marketing managers. Recommends more expansive study of broad spectrum of managers and in other	Preliminary interviews with packaging/ environmental experts and literature review. 565 sent with 196 returns (34.7%). Sample evenly split between

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
				large companies did not see significant trade off. UK based study Survey sample of 600 UK named marketing executives from commercial mailing list in food and kindred products, beverages, tobacco products, pharmaceutical, soaps, detergents polishes and sanitation goods and games and toys.	industries	large and small firms
1996	Roberts	P	Develops a profile of individuals' environmentally conscious consumer behaviour (ECCB) based upon a survey.	Investigation off the potential demographic and attitudinal correlates of ECCB and subsequent implications for advertising. Strong relationship found between perceived customer effectiveness and ECCB. Calls into doubt use of demographics as a predictor as it only explained 6% of variance. Provides literature review of green consumerism	Further work exploring the role of perceived customer effectiveness, as well as the role of individual values when transposed into the firm environment	US based Survey of 'individual green consumers' n = 1302 (46% response rate), factor analysis. Hierarchical model of multiple regressions.
1995	Halme	S	Examines the paradigm shift from traditional manufacturing thinking to environmentally related management	Provides discussion of values and culture in organisations. Explores case of Walki-Pack (a Finnish based paper corporation). Proposes two frameworks of the different paradigms	Replication of research to investigate possible paradigm shifts needed in other cases.	In-depth interviews with managers and company documentation analysis. 12 managers and 2 workers were interviewed (in 1992-1993). Industry experts from six organisations also interviewed
1995	Hart	S	Proposes a natural resource based view of the firm - a theory of competitive advantage based on firm's relationship to natural environment	Identifies three interconnecting strategies of; pollution prevention; product stewardship and sustainable development. Details a series of propositions	Hypothesis testing needed	Theory development
1995	Jahre	L	Channel structures in Household waste collection systems	Integrates logistics and marketing channel theory to develop grounded propositions. Classified according to number of important logistical characteristics and performance	Not empirically tested – narrow focus on generic recycling schemes	Pilot, semi structured interviews, theory building. Pilot studies on existing Norwegian schemes and interviews with two recycling organisations. Main study examines 37 secondary sourced examples supplemented by qualitative data collected by semi-structured interviews of further 10.
1995	Murphy *et al.*	L	Examines role and relevance of logistics to corporate environmentalism.	Based on data partly reported in 1994 paper. Different propositions focussing on: That environmental issues are and will continue to be important to business (60% respondents	Comparative studies needed. Examination of role and relevance of logistics compared to other functional areas of the firm such as production and	Same research instrument as Murphy *et al.* (1994)

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
				believed importance of environment issues was 'high' Firms are designating operational units for managing environmental issues (most frequently cited was a dedicated environmental health and safety unit) Firms have policies and guidelines for dealing with environmental issues (61% had formal or informal guidelines on the environment) Logistics has a role in formulating and carrying out company environmental policies There is an identifiable set of strategies currently being used to respond to environmental issues in logistics.	marketing.	
1995	Rogers	RL	Examines issues in store for the computer industry in light of forthcoming take back legislation. Examines whether 'closing the loop' will have a competitive advantage and what impact and industry led consortia initiative might have	Discussion of possible sector response to environmental legislation (computer industry)	Needs in-depth verification via specific investigation in the industry	Descriptive secondary based study. Some elements of theory building.
1995	Sarkis and Rasheed	S	Discussion paper on aspects of greening the manufacturing function from the perspective of an environmentally conscious manufacturing strategy	Discusses some of the major environmental manufacturing initiatives in US, Europe and Japan. Argues that environmentally responsible strategies can neither originate from nor be confined to any one functional area and should be an integral part of corporate strategy and every functional area.	Identifies the need to develop methodologies for the economic evaluation and justification of ecbp.	Secondary based overview of theory and practical examples
1995	Strong	P	Examined the environmental influences in the decision making process of grocery retail buyers	Examined the relationship the buyers had with the suppliers in terms of environmental performance and standards reached and formed tentative conclusions on factors that retail buyers considered when making environmental purchasing decisions	Exploratory study, only 22 responses. Focus on retail sector only.	Surveyed UK Grocery retailers and buyers in the eight largest grocery retail organisations. Original sample 66 (22 responses). Survey using Always-Never four point scale.
1995	Wu and Dunn	L	Discussion of the interface between logistics and environment. Overview of environmental decisions at each stage of logistics	Provides a theoretical overview of environmental aspects of the logistics function	Needs in depth testing of each of the elements identified in the green logistics process.	Theory building and discussion
1994	Drumwright	P	Examines the intra-organisational factors that influence socially	Concern for the environment is an example of a broader trend to incorporate social responsibility	Focus on intra rather than inter-organisational factors. Needs to be	Case Study/ Interviews with 10 organisations recognised for their

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
			responsible buying	into business. Policy entrepreneur and organisational context are most critical factors. Provides initial grounded theory of intra-organisational factors. Identifies 2 types of organisational players process entrepreneurs and converters and 4 types of organisational actors	empirically tested. Due to confidentially issues industries not identified but appears US based	socially responsible behaviour (63 interviews)
1994	Kroon and Virjens	RL	Examination of returnable containers as a form of reverse logistics	Designs a quantitative model of a return logistics system in the Netherlands and reviews the different systems that can be used to deal with returning used containers	Narrow focus – not tested	Extrapolation of an existing case study of such a design in Netherlands
1994	Livingstone and Sparks	L	Reports the findings from a survey conducted with Scottish exporters	Larger Scottish exporters are more aware of German legislation than smaller companies with respect to influence of German Packaging Ordnance that affects exporters	Empirical evidence gathered via mail survey but there is not a conceptual, grounded framework or hypothesis testing	Questionnaire/ Descriptive
1994	Murphy *et al.*	L	Examination of environmental issue in logistics	Examines importance of selected environmental issues to logistics. The impact environmental issues will have over the next 5 years. Environmental strategies currently being used in logistics and their effectiveness. Most important issues were hazardous and solid waste disposal. Least important were efficient land use and issues of congestion. Environmental issues believed to have most impact on logistical functions of salvage, scrap disposal and packaging. Recycling materials, reducing consumption and reusing materials were most commonly used strategies	Tended to gain response from large firms. More empirical research needed on management of environmental issues in logistics. Comparative studies from other nations, and from managers in other functions. More research on costs and optimal procedures for operationalising strategic alternatives.	Mail survey of members of the council of logistics from manufacturing and merchandising firms (n=448) 135 responses received (29.7% response rate)
1993	Kiopicki *et al.*	RL	Managerial guide to planning and implementing waste reduction programmes.	Exploratory research using a combination of case studies and interviews. Adaptation of waste management theory to the reverse logistics discipline	No grounded conceptual framework	Book/ research study with descriptive cases
1992	Cairncross	RL	Explores reverse logistics and European regulations	Describes the effect of EU regulation on firms in Europe and provides suggestions and examples of how companies are proactively dealing with regulation	No conceptual framework or empirical evidence	Theory Building
1992	Pohlen and Farris	RL	Channel structure in plastics recycling. Compaction and routing issues related to transportation issues for reverse logistics	Tests the Gulitinan & Nwokoye (1975) model identifying different channel structures. Details the functions of reverse channel members and directions for future research	Primary focus on recycling	Literature review and interviews with relevant government and company representatives

Date	Author(s)		Overview	Contribution	Future Work/ Gaps	Type of Study / Article- Description
1992	Stock	RL	Council of Logistics review of reverse logistics	Provides overviews of specific cases of reverse logistics and benefits that ensue.	Descriptive study that needs theory development	Descriptive analysis and review. Interview and phonecalls to various companies who were members of Council of Logistics

Key to Focus: P- Upstream focus L- Downstream Focus S – Across Supply Chain RL – Reverse Logistics O – Other

APPENDIX 1.2: SPECIFIC RESEARCH GAPS IN GREEN SUPPLY CHAIN MANAGEMENT RESEARCH

Appendix 1.2 identifies the specific research gaps identified in previous research studies on aspects green supply chain management presented in appendix 1.1

Research Questions and Themes that need further investigation in Green Supply Chain Management Research

Research Questions/ Area of Future Study	Author(s) that Identify Research Gap
An exploration of the role of green consumption rather than green purchasing with reference to the green purchase gap.	Peattie 1995
• Testing of the supported hypothesises of Carter and Carter (1998) when examining inter-organisational factors affecting purchasing • Testing the propositions of inter-organisational factors affecting reverse logistics by Carter and Ellram (1998) based on those identified in Carter and Carter (1998) • Synthesis of the studies of Carter and Carter (1998) and Carter and Ellram (1998) to investigate inter-organisational factors across the supply chain.	Carter and Carter 1998; Carter and Ellram 1998
Testing the theory that environmental purchasing and supplier selection leads to a reduction of the supplier base.	Robinson 1991; Taylor and Welford 1993; Paul 1996; BiE 1997;.
The extension of green supply chain management practice (green multiplier effect) past the first tier of supplies	Lamming and Hampson 1996; Ytterhus *et al.*1999
Does supply chain management actually change the environmental performance of suppliers beyond that of responding to a specific supplier request?	Green *et al.* 1996
Measurement of supplier environmental performance	Noci 1997; Enarsson 1998; Min and Galle 1997
Supplier selection processes- Modelling and identifying the mechanisms by which firms select suppliers based, or influenced ,by environmental criteria	Strong 1995; Green *et al* 1996, 1998; Hutchinson 1998
The need to stratify the selection of suppliers, based on performance criteria or inherent characteristics – ecological triage	Holt and Viney 2001
The relationship between individual purchasing managers abilities and green purchasing behaviour	New *et al.* 2002
What benefits and pressures companies face due to environmental issues and the influence of these on environmental management and green supply chain	Pohlen and Farris 1992; Shrivasta and Schot 1992; Meffert and Kirchgeorg 1993;

Research Questions/ Area of Future Study	Author(s) that Identify Research Gap
management. • Role of legislation as identified by Pohlen and Farris 1992. • Role of customer pressure (Shrivasta and Schot 1992. • Influence of contractual agreements as opposed to regulatory pressure (Hass 1996). • Examination of "win-win' scenarios in a more structured manner. Who benefits from green supply? (Morton 1996). • Effectiveness of the ecology push and pull green supply drivers (Meffert and Kirchgeorg 1993; Linnanen and Halme 1995). • The relationship between sector and other classifying criteria and the type of pressure exerted through the supply chain (Baylis *et al.* 1998a, 1998b). • Internal and external forces that drive green supply (Cramer 1998)	Linnanen and Halme 1995; Hass 1996; Florida 1996; Hill 1997; Morton 1996; Baylis *et al.* 1998a, 1998b; Cramer 1998.
Factors that need to be overcome in order to achieve sustainability and the role green supply chain management can play in this. Obstacles faced by companies implementing green supply chain management	Handfield *et al.* 1997; Min and Galle 1997; Schaefer and Harvey 1998.
How firms receive external environmental signals and translate these into action in different functional areas (such as marketing purchasing)	Green *et al.* 1996, 1998; New *et al.* 1999
Differences in inter-corporate power and that affects green supply chain management responses	Green *et al.* 1996
To examine individual reverse logistics applications and modelling closed loop networks	Johnson 1998; Jayaraman *et al.* 1999
To test the quantitative models of product recovery networks	Fleischmann *et al.* 2000, 1997; Pohlen and Farris 1992
The role of partnerships, agreements and strategic alliances in the supply chain and how that influences environmental behaviour	Paul 1996; Baylis *et al.* 1998b; Robinson 1991; Gupta 1995; Kybert 1993; Pohlen and Farris 1992; Hass 1996
Replication of assessment of 'progressive, moderates and conservative, attitudes to the environment as propose by Murphy *et al.* (1996) extended to include green supply chain management rather than just logistics	Murphy *et al.* 1996
Revalidation of the findings of Murphy *et al.* (1994) needed in different countries and functional areas	Murphy *et al.* 1994
Revalidation of the propositions posed by Murphy *et al* 1995 needed (regarding logistics and environmental management)	Murphy *et al.* 1995
Complete identification of costs and benefits of reverse logistics	Pohlen and Farris 1992

Research Questions/ Area of Future Study	Author(s) that Identify Research Gap
Examination of the strategic role of green supply chain management and the link with the corporate goals and mission	Drumwright 1992, 1994; Zsidisin and Siferd 2001
Comparative studies of different policies on green supply chain management in different organisations	Green *et al.* 1996
Longitudinal studies on green supply chain management practices	Carter and Carter 1998
Studies that examine the whole of the supply chain and practices of green supply chain management	Wu and Dunn 1995; Cramer 1998; van Hoek 1999
Does green supply chain management lead to improved financial performance?	Carter *et al.* 2000
How and why organisational purchasing behaviour occurs	Polonsky *et al.* 1998; Drumwright 1992, 1994
Comparative studies that explore the difference between different countries and cultures and how that effects green supply chain management	Carter and Ellram 1998
link between green supply chain management and TQM	after Anon 1997; Caddick and Dale 1998
Need to examine the inter and intra-organisational factors affecting organisations in a green supply chain in one study	Carter and Ellram 1998
Integration of existing research and theories into research studies on green supply chain management	Murphy *et al.* 1994, 1995, 1996; Klassen and McLaughlin 1996; Carter and Carter 1998; Carter *et al.* 1998 2000; Carter and Ellram 1998; Zsidisin and Siferd 2001; Faruk *et al.* 2002

The following comments highlight some of the research in the above table outside the remit of this current research and may provide future avenues for green supply chain research.

Carter and Carter (1998) examine inter-organisational factors that drive environmental purchasing activities. This work examines how upstream members of supply chain impact upon environmental purchasing activities and what actions environmental purchasing managers can take to manage these impacts. This work concludes with three recommendations.

- That future research should examine second and third tier suppliers.
- That organisational factors, such as the presence of incentive reward system for employees, role of green champions, environmental commitment of the organisation, should be examined
- The need to for inter-functional research especially the interaction between purchasing and marketing, since no studies currently examine this aspect (also raised by Green *et al.*

1996, 1998; New *et al.* 19990

Green *et al.* (1996, 1998) also suggest the need to examine the mechanisms within firms by which environmental signals are received and translated into action by purchasing, marketing and R&D functions. A view echoed by New *et al.* (1999) who state that understanding the mechanisms of environmental supply chain interaction are vital if the process of consumer pressure is to be understood. However, New *et al.* (2002) also note that differences in green purchasing behaviour may have more to do with the personal abilities of purchasing managers and others in functional roles rather than organisational characteristics and this should be considered in future research.

Carter and Carter (1998) develop a theoretical framework of the factors driving, and constraining, environmental purchasing activities and the hypothesises they test are reiterated as untested propositions from the perspective of green logistics in later work by Carter and Ellram (1998). Their propositions suggest critical factors in the reverse logistics system and these have not been validated empirically. This green purchasing framework (Carter and Carter 1998) is exploratory and should be tested further, especially in a outside of the US. All the Carter based studies (Carter and Jennings 2001; Carter *et al.* 1998, 2000; and Carter and Carter 1998) use the data reported in Carter and Carter, 1998).

The strategic role of reverse logistics is examined by authors such as Murphy *et al.* (1994, 1995, 1996) who examined the *predicted* role of logistics in green supply chain management over a five-year period in the USA. However, as Carter and Carter (1998) note there is no evidence of longitudinal work on green supply chain management, tracking *actual* changes over time, rather than *predicted* issues or *levels* of concern (for example Monicka and Trent 1995 or Murphy *et al.* 1994-6). Hall (2000) also identifies the need for research in leading edge companies to examine event histories of green supply chain management practices over time.

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APPENDIX 2: THE ROAD TO ENVIRONMENTALISM IN BUSINESS

This appendix presents a brief introduction to some key concepts and theories discussed in this thesis, allowing the reader to appreciate some the wider elements of the topic of environmentalism in business, without distraction in the main body of the text.

2.1 The Rise in Concern for Environmental Protection and Management

Man's impact upon the environmental and the consequences of this are not a modern day phenomenon. The first literate civilisation of the world, the Sumerians of Mesopotamia collapsed as a result of environmental change from excessive salinisation caused by their agricultural practices (1800BC). Whilst the population of Easter Island (after 1600AD) collapsed due to deforestation. Ponting (1991) in his book 'Green History of the World' points to examples of man's impact upon the environment since the dawn of recorded history and archaeological records. However, whilst anthropogenic changes in the natural environment are not a new phenomenon, the level of concern about man's impact upon the environment, potential scale of environmental change and cumulative impacts of man's activities have reached unprecedented levels from the latter half of the 20th Century onwards.

De Steiguer (1997) reviews the contribution of the key figures to the 'Age of Environmentalism' heralded by the publication of Rachel Carson's Silent Spring in 1962. The writers of this period (from 1962- mid 1970's) developed the classic body of environmental literature underpinning much of the research in this area today. The goal of Hardin, Ehrlich, Commoner and many others was the *'reform of human attitudes and behaviour regarding the environment'* (de Steiguer 1997:3). The commercial success of their work also served to popularise the environmental movement. Yet these scholars who contributed to the of the 'Age of Environmentalism' were influenced by scientists and philosophers from the post industrial revolution period as far back as St. Francis of Assisi (Sessions 1995). Thomas (1983:15) notes that it was

> *'between 1500 and 1800 that there occurred a whole cluster of changes in the way that men and women, at all social levels, perceived and classified the natural world around them. It was these centuries which generated both an intense interest in the natural world and those doubts and anxieties about man's relationship to it which we have*

inherited in magnified form'.

Many of the 'contemporary' ideas of the 1960's and 70's were reinstatements of earlier environmental thought, from contributors such as Malthus, Mill, March and Muir to name a few (de Steiguer 1997).

However, widespread public concern for the environment is primarily a 20th and 21st century phenomenon, although it could be argued that localised, issue based concerns have occurred over the centuries. It is perhaps a combination of environmental education in schools, and the cumulative affect of constant exposure of environmental issues to the general public through pressure groups, media, advertising, and high profile disasters (such as Chernobyl, Exxon Valdez, Braer oil spill, Bhopal and many others) that has led to the growing awareness of the finite capacity of 'Spaceship Earth' (after Boulding 1966).

Dunlap (1991) reviews the trends in public opinion towards environmental issues from the 1970's through to 1990. Caldwell (1991) states that governments did not concede the political legitimacy of environmental issues until the 1960's and 1970's. From this time period citizen groups grew in strength and number, and many of the modern day environmental pressure groups evolved during this period. By1993 there were 230 000 members of Friends of the Earth in the UK, 390 000 members of Greenpeace, 850 000 members of the RSPB and over 2.2,million members of the National Trust (Macnaghten and Urry 1995). During the 1970's the focus of environmental concern was on the continued supply of resource (linked to things such as the OPEC oil crisis) but since the 1980's there has been a significant development of awareness of the finite assimilative capacity of the globe to absorb waste and pollution (Hutchinson and Hutchinson 1997).

Macnaghten and Urry (1995) state that the social and political threads to contemporary environmentalism are complex and that they are tied to the emergence of other social movements and other globilising factors. Theorists have identified environmentalism as a struggle against the *'self defeating process of modernisation'* (Eder 1990), tracing environmentalism as part of an emerging critique of contemporary society. Lowe and Goyder (1983) identify four high water marks in environmental concern: the 1880's, the 1920's, the late 1950's and the early 1970's which Peattie (1995) believes are part of a tightening and deepening spiral of environmental concern.

Each period of heightened environmental concern coincides with a period of sustained economic growth and Peattie (1995) believes that at such times the environmental consequences of growth are the most obvious, and the tendency to react against materialistic values will be strongest. Yet, McCormick (1989) believes that it was actually in the depression of the 1880's that the benefits of industrialisation were seriously questioned for the first time, demonstrating a growing belief that industry was destructive to the moral and social order, human health, traditional values, the physical environment and natural beauty.

2.2 Themes associated with the Environment

Pepper (1984:14) notes that it is difficult to define exactly when *'modern concern'* about the environment initially began and that it is probably more useful to use the publication of certain landmark publications and events (such as the publication of Silent Spring (Carson 1962)). Yet there are key themes of 'concern' that seem permeate both modern and antiquarian environmentalist debates. Themes that are enshrined in modern day concepts such as eco-efficiency, sustainable development, ecological footprinting, and cut across the boundaries of culture, location, religion and historical period.

These themes of environmentalism are focussed around:

- *The concept of resource scarcity*. Initially discussed by Malthus (1798) who predicted a world where population expansion was kept in check by famine, war and disease. In 1972 the Limits to Growth team of Meadows *et al.* used a computer simulation that in essence predicted a Malthusian based resource scarcity. Today we can see parallels between Malthus' ideas; Limits to Growth and the current day emphasise on reduction, reuse and recycling;
- *The danger to human health by the reduction in the quality of the environment, through resource degradation and anthropogenic substances*. From the earlier writings of Mill (1848), to the Public Health Act of 1895 (Ball and Bell 1997) to Carson (1962) and her work on the impact of pesticides, to the modern day BSE and GM crisis's, the 'danger' to man caused by his use and abuse of the natural environment, remains a source of constant concern; and
- *The sanctity and/or appreciation for 'nature'*. The Romantic movement of the 18th and 19th

century, as epitomised by the American transcendentalists, underpins modern day ecocentrism (as classified by O'Riordan 1976) Transcendentalist writing focuses on an appreciation for nature in all its forms, clean air, sparkling rivers, dramatic landscapes and solitude with nature. Thoreau's two-year sojourn based at Walden Pond (Thoreau 1854) came to represent an idyllic lifestyle where materialism was rejected for the spiritual fulfilment of time spent close to nature. Pepper (1984) states that it was Thoreau's phrase *'In wilderness is the preservation of the world'* which founded the US National Parks system. It was the Scot, John Muir, with his close affinity to nature, who founded the Sierra Club in 1892 (this spawned the breakaway Friends of the Earth in 1962).

2.3 The Philosophies of Environmentalism

O'Riordan (1976) defines the ecocentric-technocentric continuum of environmentalism. This continuum defines the philosophical foundations upon which environmentalism is built, ranging from the ecocentric to the technocentric. Much of modern environmentalism could be said to have emerged from these foundation paradigms.

'Frontier Economics' was a term coined by economist Kenneth Boulding (1966) to describe the dominant social paradigm of the industrialised world up to the late 1960's (Catton and Dunlap 1978). This viewpoint has a Cornucopian - Technocentric basis, whereby nature has an infinite capacity to provide resources for human development and an infinite capacity to absorb the by-products of such activity and embodies the philosophical ideas of Bacon[1], Descartes[2] and Galileo[3].

The 'opposite' paradigm, ecocentrism, is fundamentally opposed to the tenets of technocentrism. This 'deep ecology' (after O'Riordan 1976; Egri and Pinfeld 1994), 'radical environmentalism' (Egri and Pinfeld 1994), or 'ecocentric' (Gladwin *et al.* 1995; O'Riordan 1972) paradigm believes that nature has an intrinsic value. Advocating social and biological arrangements where there is a balance between the interests of humanity and nature (Egri and Pinfeld 1994).

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[1] who proposed that knowledge meant power over nature and therefore science was the only valid viewpoint

[2] developed the idea of mind over matter

Corporate environmentalism is associated with the accomodator paradigm of environmental management, and lies between the technocentric and ecocentric position. Within the O'Riordan continuum, environmental management is a technocentric-orientated paradigm and operates within established political and economic structures. It seeks to achieve incremental change to political and economic structures in order to bring about environmental protection and enhancement. Its ethical roots lie in intergenerational stewardship, that of stewardship of nature for future generations (rather than for God which is the basis of Christian stewardship). It's scientific roots lie in that of holistic systems science as introduced by Darwin yet its scientific roots also owe much to the legacy of the Cornucopian position. Reductionism, (breaking science into small sub units for in-depth study) so much a part of Cornucopianism, was an essential first step in the understanding of global environmental systems. Environmental science involved the reintegration of the reductionist disciplines into a new discipline, allowing environmental scientists to study the environment from a holistic systems basis (White *et al.* 1987).

Ashby (1978) argues there was a prevalent shift from Cornucopian ideals to those of the accomodator paradigm in the western world. Many believe that dominant political interests hijacked environmentalism in order to retain control over this shift, in order to avoid any more dramatic swings (Sandbach 1980). This cynicism of Sandbach and others is echoed more recently by Tokar (1997) who states that grassroots local environmental activists in the USA do not believe that high profile national environmental pressure/lobby groups are capable of adequately defending the integrity of the natural environment. In the pursuit of influence amongst the decision makers in the political and corporate world these groups have institutionally tied themselves to the political and economic establishment and sought an accommodation with the powerful interests responsible for environmental destruction argues Tokar (1997:xi). Toker identifies the three main developments that have led to a corporate greenwash as: the absorption of the mainstream environmental movement by the political status quo; the phenomena of the emergence of corporate environmentalism; and the proliferation of 'ecological' products in the marketplace.

Gladwin *et al.* (1995:890) states that the competing nature of these the philosophical positions of technocentrism and ecocentrism fails to offer a basis upon which sustainable development

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[3] who developed the analytical frameworks that divided subject from object and further

can occur. This is a view endorsed by Hoffman and Ehrenfeld (1998), who believe that this fundamental dichotomy of the ecocentrism-technocentrism paradigms will result in emerging environmentalism paradigms at their interface. Gladwin *et al.* (1995) presents the concept of 'sustaincentrism' as an emergent embryonic synthesis since, as they state, neither ecocentrism nor technocentrism can 'solve' the environmental crisis. Sustaincentrism draws its inspiration from claims of the universalism of life, stewardship, ecological economics, scientific and resource management and emerging scientific theories based on nature's dynamic complexity and inherent self-organising properties.

Hoffman and Ehrenfeld (1998) state that to consider the bounds of environmentalism one must acknowledge that it represents a broad social movement that is neither monolithic nor static. Hoffman and Ehrenfeld (1998) present a model of the historical progression of environmentalism and its future direction, using the work of Colby (1989), Egri and Pinfield (1994) and Gladwin *et al.* (1995). This model uses the five fundamental paradigms of environmental management presented by Colby (frontier economics, deep ecology, environmental protection, resource management and ecodevelopment), as well as the three ideologies presented by Egri and Pinfield - (dominant social paradigm, radical environmentalism, and reform environmentalism); together with the three ideologies of Gladwin *et al.* – (technocentrism, ecocentrism and sustaincentrism). The Hoffman and Ehrenfeld evolutionary model explores the diametrically opposed nature of the two foundation paradigms of environmentalism, that of frontier economics (the dominant, technocentric orientated social paradigm of industrial society) and the ecocentric, deep ecology viewpoint. They argue that the interface of these two ideologies has led to the emergence of evolving philosophies of reform environmentalism (resource management and environmental protection). This interface zone of evolutionary change, with a constantly evolving state of policy, practice, accepted norms, beliefs and values, should in Hoffman and Ehrenfeld's view lead to revolutionary change and 'sustaincentrism' (after Gladwin *et al.* 1995) or Colby's 'ecodevelopment' (Colby 1989).

In essence, environmental reform is a response to environmental issues and the rising concern of society. The slow death of the frontier economics philosophy within the industrial world began in the 1960's with landmark events such as the publication of Silent Spring and growing societal concern about the impact of anthropogenic activity upon the natural environment. It

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developed dualism

could be argued that current corporate environmentalism is a response to the requirement for environmental reform generated by legislation and societal requirements and lies within this zone of 'evolutionary change'. This 'environmental reform' may range in scale from small incremental changes through to fundamental realignment of corporate practice and values that verge on a revolutionary change to 'sustainability'. However, whether an individual firm could ever wholly achieve this ideological shift to a 'revolutionary' position is debatable if wider society significantly lags behind (Holt and Viney 2001).

Thus, it could be argued that we are in a state of evolutionary change, arising from the two opposing paradigms of ecocentrism (deep ecology) and technocentrism (frontier economics) where it is hoped this evolution will lead to a goal of sustainability or sustainable development. Sustainable development is defined as;

> *'a synthesis of environmental protection, economic prosperity and social justice that protects and restores the natural environment, improves the quality of life, and preserves environmental and economic prospects for future generation'* (Sexton 1999:447).

At what stage society or individuals are at within this state of evolutionary change is open to debate. However, environmentalism is moving towards some new reality (Hoffman and Ehrenfeld 1998). The changes in societal environmental awareness, knowledge, cultural norms and values are leading/forcing companies into changing their policies and practices. Corporate environmental management is an expression of this evolution from foundation environmentalism, into reform environmentalism to ultimately transform industry, along with a value shift in society, into this penultimate stage of sustaincentrism/ ecodevelopment. The response of industry to environmentalism is detailed later but the philosophical foundations of the corporate environmental movement are firmly embedded in the environmental management paradigm, with arguably vast majority of industry falling into the foundation and evolutionary stages (Hoffman and Ehrenfeld 1998). The practical response of industry reflects the paradigm of reform environmentalism, which is clearly linked to the underlying themes of environmentalism, resource scarcity, human health and the value of 'nature'.

2.4 Environmentalism and Business

> *'The truth is no matter how environmentally responsible, few companies will ever be truly good for the earth. The most we can hope for is for companies to do the least damage in pursuit of productivity and profits' (Makower 1993:4)*

The pragmatic approach presented by Makower (1993) focuses on two core elements to greening business: reducing waste and maximising resources by considering the E-Factor (the environment) in the decision making process. Makower states that the E-Factor *is 'not about turning your company's policies, products or processes topsy-turvy in the name of Planet Earth, but is simply another part of the fine tuning process that operates in every organisation'* (Makower 1993:7). This fine-tuning bears strong parallels with the TQM movement seen in the last 2 decades.

Corporate Environmental Management or what has become known, as 'corporate environmentalism' is industry's expression of the Environmental Management paradigm (after O'Riordan 1976). Makower's stance on the E-Factor is a classic expression of the environmental management accomodator paradigm, with the focus on waste and maximising resources found at the heart of the eco-efficiency philosophy. Corporate environmental management is a win-win philosophy whereby free market mechanisms and bottom line impact will push companies into a more environmentally sustainable path. Recent years have seen an increasing emphasis on the promotion of certain kinds of environmental behaviour based upon its impact upon the profitability of a company- the so-called green bottom line (Elkington 1998; Saunders 1993). The focus on eco-efficiency, waste minimisation and other competitive or cost saving measures have been advocated as a way to make environment improvements 'pay their way' and to utilises a language that would be 'understood' by the business world.

There has been recognition from the 1990's onwards of the importance of the green agenda at the national policy level and the competitive advantages that it can bring to business. This is a far cry from the situation in the Thatcherite era when environmental policy exhibited a pronounced ideological change (Blowers 1987) with a narrowly focused and selective policy agenda designed to appeal to partisan interest (primarily big business, southern and rural England). Interestingly Blowers predicted, successfully one might argue, that the EEC Directives would transform British policy away from pragmatic regulation to environmental quality objectives and standards. He also noted that the Thatcher government's approach to the environment might have in fact focussed debate on environmental issues, which helped develop the environment into a significant issue in national policies and politics. The October 2000 speech by Tony Blair to the CBI on the importance of green issues is evidence of its role within the UK governmental agenda. The idea of the importance of environment protection is becoming more widespread in the UK, reinforced by high profile events such as the 2000 floods, BSE and Foot and Mouth crises.

Thus, the creation of the Advisory Committee on Business and the Environment (ACBE) in May 1991, was a reflection of the growing role of environmental issues in business and government. The panel, established by the Department of the Environment and the DTi, was chaired by John Collins the then CEO of Shell, and the Committee contained representatives from a range high profile corporations. Their stated aim was to focus *on those issues of environmental policy where it believed business could make the most significant impact* (ACBE 1991:12). Since then ACBE has published yearly recommendations to the government on a range of aspects of environmental policy that clearly indicate the key national and international issues, many of which focus on the market based mechanisms of corporate environmentalism.

The Institute of Directors 1994 survey (IoD 1995) stated that environmental issues featured on the agenda of 58% of the boards of companies surveyed, with Directors expecting an increasing amount of time to be devoted to environmental issues in the future. This is a view endorsed by Stoner *et al.* (1995) that put the environment at the top of the list of workplace issues for managers in this new century. In 1998, the Institute of Management found that only 2% of respondents surveyed were sceptical of the importance of the environment as a business issue (IM 1998).

In 1998 the UK Government's Consultation Paper *Opportunities for Change* (DETR 1998a) was published. It was the first in a series of linked consultation papers including those on *Sustainable Business* (DETR 1998b) and *Sustainable Waste Management* (DETR 1998c). The content of these consultation exercises and the yearly ACBE report and governmental response, clearly indicates a governmental awareness of ecological issues.

Sustainable Business (DETR 1998b) identifies five themes that provide a framework for action in promoting sustainable development and the implications for business.

- Ways to encourage the development of goods and services which meet people's needs but involve the use of fewer resources (*business implication - more emphasis on services rather than units of production)*
- Promoting sustainable communities for people to live and work in *(contributing to the needs and aspirations of employees, the local community and other stakeholders)*

- Policies to manage and protect our environment and resources *(avoiding harmful impacts and adopting best practice and innovation in developing new products and processes which use fewer resources)*
- Sending the right signals through price, regulation, and information for the public *(reflecting environmental costs in the price the consumer pays and enlarging and stimulating customer choice)*
- International/transboundary actions *(applying effective environmental and social standards and principles world-wide which respond to the needs and values of stakeholders in this country and in the other communities with which businesses trade)*

2.5 The Integration of Environmental Management into Business

Frankel (1998) identifies three stages of corporate environmentalism, which could also be applied to society as a whole. The first stage is described as the '*era of compliance*', characterised by an increase in environmental legislation and the assurance by industry that they were adhering to environmental laws, many of which were 'command and control' edicts relating to specific substances or circumstances. Bell (1997) states that modern environmental law began sometime in the early 1970's, with the main emphasis at that time being on health and safety issues.

Frankel believes that the second age of environmentalism began in December 1984 with the Bhopal disaster, the 'environmental equivalent of Pearl Harbour' (Piasecki 1994:24). This disaster, with its horrific human cost, led the chemical industry to transform operational processes; re-examine community (and other stakeholder) concerns and reoriented external corporate communications. This process, initiated by the chemical industry was followed by a number of other multinationals.

The heightened scrutiny companies faced ushered in the third age, an era of '*beyond compliance'* including such aspects as eco-efficiency, pollution prevention, waste minimisation and other win-win scenarios. During this third age corporate environmental issues emerged at the top level of national and international policy, the law-making arena and into public consciousness. The many commonalties in the classifications and models of corporate environmental behaviour, theoretical constructs developed to classify corporate response to environmental issues, appear to support the views of Frankel (examples include Bhargava and Welford 1996; Bostrum *et al.* 1992; Brockhoff *et al.* 1999; Ghobadian *et al*, 1998; Meima 1994; Roome 1992; Simpson 1991; Welford 1994).

Ghobadian *et al.* (1998) reviews some of these models in light of longitudinal data on corporate environmental strategy in large firms. They note the implicit assumption that companies will progress 'through' the classifications of many of these models towards 'excellence'. The influence of TQM on such classifications, as noted by Roome (1992) implies acceptance of the idea of continuous improvement, a view supported by Hass (1996:60) where '*evolutionary assumptions and logic*' suggests a sequential, continuous process. Hass in fact differentiates between progression type models and the 'categorical' type where no progress is implied, perhaps more of a 'snapshot' of current position.

Societal changes, as discussed in light of the emergence of environmentalism, have led to an increasing awareness of ecological issues in society and the many stakeholders in business. The key themes of resource scarcity, human health and preservation of nature are all reflected in the topics covered in the national policy debate. An individual's environmental attitudes demonstrate many of the key concepts of environmental management, ecocentrism and sustainable development, perhaps reflecting the general level of societal green awareness (Holt and Anthony 2000).

2.6 Environmental Management in Organisations

The literature detailing practical environmental management is vast. Overviews of the techniques and tools with examples are provided by Bansal and Howard 1997; Hutchinson and Hutchinson 1996; McDonagh and Prothero 1997; Welford and Gouldson 1993; Welford 1994:1996; Willums 1998.

Welford (1996) identifies the three focuses of environmental management as: **Policy** (including environmental management systems, policy statements, audits, impact assessment, reporting, supplier management, green marketing and staff training); **Process** (process intensification, reduction of toxicity, end of pipe solutions, waste management and research and development); and **Product** (design for the environment, eco-labelling and packaging). Green supply chain management involves all three of these dimensions.

2.6.1 Environmental Policy

Many organisations have included environment issues and objectives in their corporate mission statement and/or as part of a separate policy on the environment. In 1994 more than 95% of a sample of the UK's 200 top grossing companies had an environmental policy (Ghobadian *et al.* 1995), of which 54% had had this policy between two and five years. The environmental policy is an artefact of culture (after Brown 1998) that demonstrates the organisation's commitment to environmental issues and provides a visible reflection of the core values of an organisation (Holt and Anthony 2000). ISO (1996) define an environmental policy as a statement by the organisation of its principles and intentions in relation to its overall environmental performance, which provides a framework for action and for the settings of its environmental objectives and targets.

It could be argued that it is the corporate values that are being 'cascaded' through the supply chain, set by the corporate environmental policy, either through active vendor management or best practice influence. In fact, Sutton (1997) argues that a 'sustainability seeking' firm will actively reach outside the boundaries of their own organisation in order to influence the rest of society. This influence will occur through an organisation's indirect and direct interaction at all levels with individuals and other organisations, not just those firms linked directly via a first tier supply chain.

A wide range of standards are being developed that assist in benchmark products and companies. Verification of a company's internal environmental management system can be provided by accreditation to an environmental management standard such as ISO14001 or Eco-Management and Auditing Scheme (EMAS). There is also a new ISO14031 standard on Environmental Performance Evaluation explored by Bennett and James (1999).

2.6.2 Environmental Management Systems and Standards

An Environmental Management System (EMS) is that part of the overall management system which includes the organisational structure, responsibilities, practices, procedures, processes and resources for determining and implementing the environmental policy. The accreditation of a company's internal EMS via an environmental management standard such as ISO14001 or EMAS allows the external verification of the procedural basis of the EMS. Green business groups and governmental environmental departments typically suggest accreditation to one of the environmental management standards may bring tangible benefits and add value to a firm. Sunderland (1997) examines the benefits from EMS accreditation and how such standards are used in benchmarking leading edge companies and providing a mechanism to demonstrate to stakeholders their good corporate citizenship. The potential benefits of accreditation to an EMS are also examined by Holt (1998) who notes that such accreditation may lead to efficiency gains but intangible benefits associated with aspects such as image are less easy to quantify.

Clayton and Rotheroe (1997) and Baylis *et al.* (1998) identify the role of ISO14001, BS7750 and EMAS in focussing attention upon suppliers, with EMAS standard making specific reference to the need to consider and address the environmental performance and practices of contractors, subcontractors and suppliers. Sunderland (1997) also states that an EMS standard may assist companies in export markets with companies in Asia and Latin America gaining accreditation in anticipation of supply chain pressures. Willson and McLean (1996) discuss the possibility that in the US the Department of Energy and Department of Defence may extend preferential buying to qualifying suppliers who are certified to ISO14001. Sunderland (1997:132) also notes that a number of governments in Latin America and Asia Pacific are considering making certification to IS14001 a requirement for foreign oil exploration and production operators, for example the Korean Government required leading Korean companies to achieve ISO14001 by the end of 1997.

Overwhelmingly current literature supports the idea that the introduction of such standards will create supply chain pressure, and is likely to cascade the use of such standards through the supply chain (Hutchinson 1997). Yet Hutchinson (1998) notes the dissenting view raised by B&Q who have made the decision not to require suppliers to accredit to an environmental management standard, believing that many companies with limited resources were unable to spend the time and money on the management systems and issues they were designed to address. Yet B&Q have initiated a supplier audit programme that requires all suppliers to demonstrate environmental good practice in order to remain a supplier (Barry 1996; Hutchinson 1998). In fact, Hutchinson (1998:176) suggests that *'the issues an organisation's environmental management system are supposed to address are those significant to the organisation'*. So if suppliers are being forced into addressing environmental issues of importance by their customers, rather than ones internally driven, then the possibility exists that the supplier undertakes activities that deviate from the focus that the company wants to strategically take.

2.6.3 Cleaner Production

Cleaner production is a proactive approach to managing environmental impacts of production or service operations using the continuous application of clean technology (Hillary 1997). With a focus on reducing the volumes and toxicity of all emissions and wastes sources, rather than treating emissions and wastes to reduce toxicity and environmental impacts, cleaner production differs substantially from end-of-pipe treatment. While the pollution prevention concept forms the foundation of Cleaner Production, it also expands the concept to include the entire system of inputs, processes and outputs involved in a production or service activity. As such, this approach combines evaluation of production processes, products, and services into an integrated preventive environmental strategy. Through using new technology, it focuses on reducing the quantity and toxicity of emissions and wastes, conserving energy and raw material inputs, eliminating use of toxic raw materials, reducing unfavourable environmental impacts of a product's lifecycle, and reducing the environmental impacts resulting from design and provision of services.

Russel (1998), explores examples of environmentally sound technology in relation to both ends of pipe and cleaner production technologies, and identifies five ways that a company tackles it's own environmental impacts: (1) simple operating and housekeeping practices; (2) redesign/ reformulating products; (3) modifying process; (4) changing technology and (5) material substitution.

2.6.4 Waste Management

Waste is defined as 'any substance or object in the categories set out in Annex 1 *(of the Directive)* which the holder discards, or intends, or is required to discard' (1975 Directive 75/442/EEC amended by 91/156/EEC in HMSO (1994)). The DoE's 11/94 Circular debated the interpretation of the 1991 Directive on waste and argued that wastes are 'those substances or objects which fall out of the commercial cycle or chain of utility', offering the example of glass bottles. Glass bottles that are returned or reuse in their original form are not waste, whilst glass bottles banked by the public ands dispatched for remoulding are waste 'until they have been recovered' (EIB 1995).

The DoE further develops the idea of potential waste by identifying four broad categories of potential waste:

- Worn but functioning substances or objects that are still useable (albeit after repair) for the purpose they were made.
- Substances or objects that can be put to immediate use otherwise than by a specialised waste recovery establishment or undertaking e.g. ash from a power station used as a raw material in building blocks.
- Degenerated substances or objects that can be put to use only by establishments or undertakings specialised in waste recovery. These are always wastes even if transferred for recovery for value e.g. contaminated solvents or scrap. Such substances only cease to be waste when they have been recovered
- Substances or objects which the holder does not want and which he has to pay to have taken away. If substances or objects are consigned to the process of waste collection then they are waste but they may not be where they are fit for use in their present form by another identified person (HMSO 1994:41-42)

WasteWatch (1998) estimates that 414 million tonnes of waste is generated in the UK each year. Although only 27 million tonnes of this is household waste, WasteWatch estimates that for each tonne of household waste, five tonnes of waste are produced in manufacturing and 20 tonnes in the raw materials extraction phase. From an industrial ecology viewpoint waste could be considered as 'anything that does not add value' (Graedel and Allenby 1995:95) or 'resources out of place' (after Botkin and Keller 1995) emphasising that waste is not a problem that should be buried or burnt but is a resource that need to be used differently. The Environment Agency (in WasteWatch 1998) estimate that 90% of all resources we consume are either thrown away as 'waste' or discarded into the environment as effluent or air emissions. The focus on resources consumed is an important element in the drive for eco-efficiency. Therefore there has been a move towards viewing waste as not only the traditional municipal and controlled wastes, but also as resources that can be recycled, recovered or reused.

Ayres (1996:1) states that;

> *'every substance extracted from the earth's crust, or harvested from the forest, a fishery, from agriculture is a potential waste...it soon becomes an actual waste in almost all cases with a delay of a few weeks to a few years at most....... materials consumed by the economic industrial system do not disappear .. they are merely transformed to less useful forms"*

The extraction of such substances and the operation of the industrial system produces waste, which is controlled via pollution control measures. Yet such pollution control does not eliminate waste it merely shifts it to a place where it can cause less 'harm'. Ayres argues for: long term material productivity via reduction and elimination of inherently dissipative uses of non-biodegradable materials; designing products for disassembly and efficient technologies for recycling. The strategies for achieving such productivity are defined in table 2.1.

Table 2.1: Strategies for extending resource productivity (after Ayres 1996)

Strategies for Resource productivity	Examples
Dematerialization – more efficient use of a given material for a given function	Electronics industry and miniaturisation
Substitution of scarce or hazardous materials by another material	substitution of PVC for cast iron or copper, removal of CFCs
Repair, reuse, remanufacture recycling – classed as 'eco-efficiency'	recovery of catalysts for catalytic converters recycling paper, cans,
Waste Mining- utilisation of waste streams from currently irreplaceable resources as alternative sources of other needed material	waste exchange, recovery of wastes such as sulphur from flue gases desulphurisation.

Wastes can be reduced, re-use, recycled, recovered or disposed. The priority in which wastes should be addressed is encapsulated in the waste hierarchy (figure 2.1) as explored in most waste management publications (such as DoE 1995; DETR 1998c, 1998d). This hierarchy stresses the need to reduced the amount of waste created in the first instance, then re-use wastes, then recover (via recycling, composting or waste-to-energy facilities) and finally, as a last resort to dispose of waste.

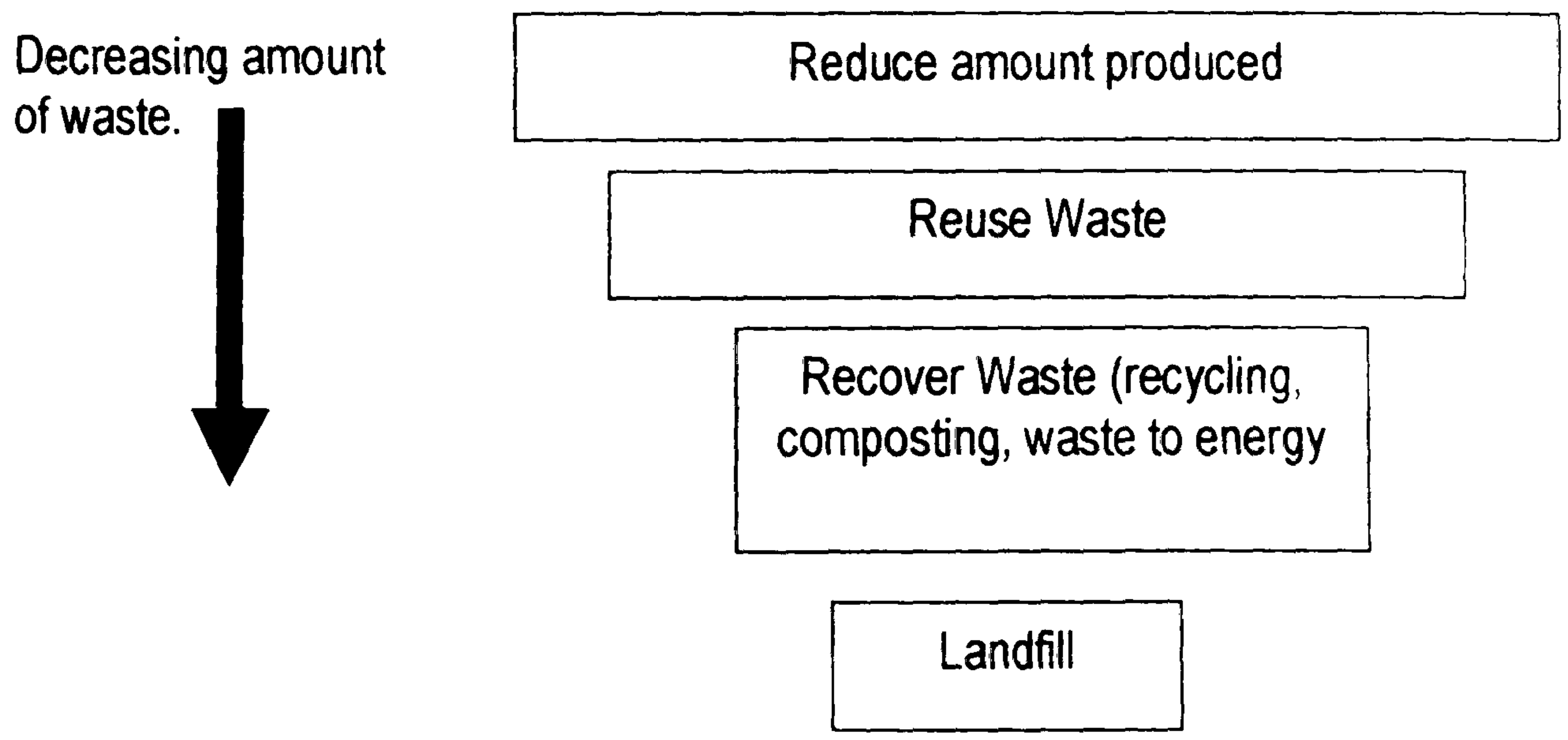


Figure 2.1: The waste management hierarchy

There is wide spread support for this theoretical hierarchy although the recent UK Waste

Strategy document states that

> *'the government supports this theoretical hierarchy but considers that it cannot be an absolute guide to the best solutions for any particular waste stream in all localities... properly used the hierarchy should challenge waste producers to look for ways of decreasing the environmental impact of their waste, or maximising the benefit that can be gained from the resources it represents' (DETR 1998d: 10)'*

The shift in priority focus in recent years from the management of waste created, through disposal and recycling, to the reduction at source of waste through waste minimisation principles is a logical result of the redefined perception of waste as 'resources out of place. Therefore, there has been the emergence of 'wider' definitions of waste such as the one from the ETBP (1997) as 'wasted time, energy, water, and the excessive use of raw materials'. An alternative definition from the US EPA of waste minimisation is that of 'source reduction and recycling' (EPA 1988) as expanded upon in figure 2.2.

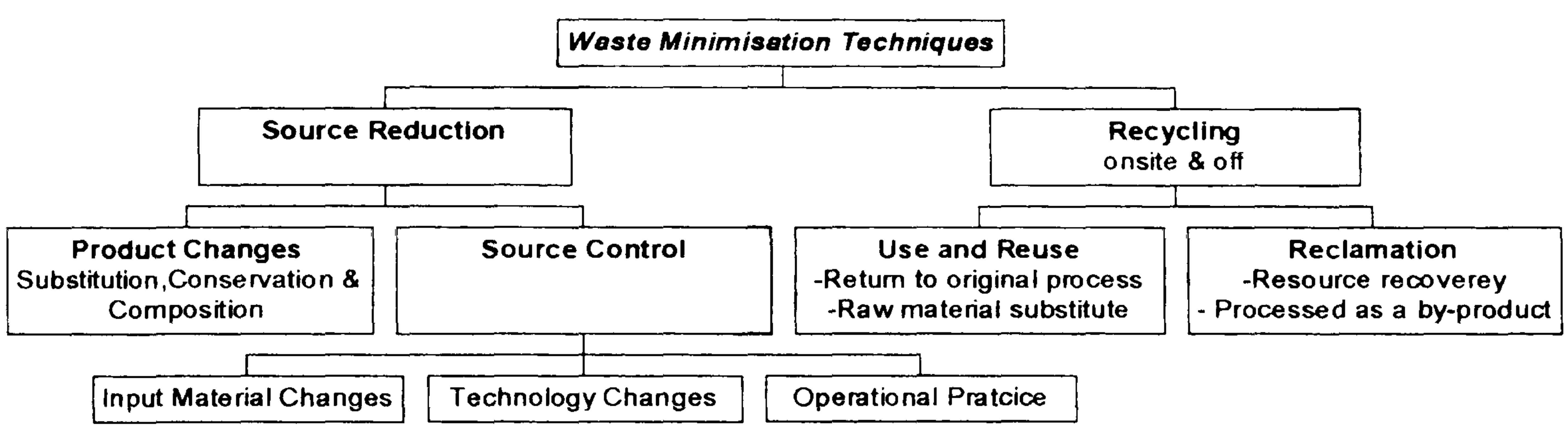


Figure 2.2: Waste minimisation techniques (after EPA 1988)

Johnson (1991:274) defines recycling as the *'return to previous stage of the cyclic process, especially to convert waste to reusable materials'*. The most commonly known application of recycling is perhaps the recycling of bottles, cans and newspapers. This type of recycling could be classed as **generic**, in that the materials recovered are from mixed sources. They are returned to a recovery agent (the waste management company that processes the materials). The materials recovered can then be used as raw material within the input function of another transformation process (e.g. recycled paper in the production of toilet paper). This approach might be classed as **generic recycling** in that the material may be from mixed sources and may be used in a new supply chain than the one in which is was originally created. A number of small entrepreneurial businesses have been set up to product products made entirely, or predominately, from post consumer waste (Bennett (1991) and Lassila (1992) detail examples of these). Lassila discuses the role that innovation plays is this so-called 'ecopreneurship' but notes the comments of a US scientist that *'the key to ending the solid waste glut is not* *innovation. It's mainstreaming. What we need is federal standards for post consumer waste content in high volume products like paper and packaging'* (Lassila 1992:41). The author also states that whilst ecopreneurial activity is not the key to solving the national solid waste problem, it is a key element in these small-scale innovative products based upon recyclables.

Those materials that are re-used are recovered and used again in their original form, and requires a controlled process of recovery where contamination and damage can be minimised. An important element of a reuse strategy must be design for disassembly and therefore eco-design of products takes centre stage, along with the recovery procedure

The return of products to the original manufacturer (**product takeback**) to be disassembled is an important element of reverse logistics and could be defined as **specific reuse or recycling**. Examples of this include the takeback of Kodak's disposable camera; Canon's toner cartridges and Xerox's photocopy machines (Ottman 1998).

Another example of specific recycling is that of '**waste exchange**'. Unlike recycling where a waste-processing agent collects end of life products or packaging, waste exchange involves the wastes from one production process being inputted into another separate transformation system in another organisation. Waste exchange networks, especially amongst SMEs are classed as an excellent example of the application of industrial ecology, as discussed later. In waste exchange the firm producing the waste, who would normally have to pay to have it disposed of, sells or gives it away to another organisation, which subsequently uses it in their own production processes.

The concept of closing the 'materials cycle' within industrial ecology is discussed by Ayres (1996:6) who suggests there are opportunities to reduce wastes and pollution by using the low-value by-products (i.e. wastes) of certain processes as raw materials for others. Erkman (1997) provides an historical review of industrial ecology and the concept is explored in depth by Ayres (1996) and Greagel and Allenby (1995). Erkman makes a clear distinction between 'industrial metabolism' and 'industrial ecology'. With the former defined as the whole material and energy flows going through the industrial system, studied as essentially an analytical and descriptive application of the materials-balance principle. Whilst industrial ecology goes further, based upon understanding the industrial ecosystem, its regulation and interaction with the biosphere to ultimately aid in the restructuring in a way that is compatible with natural ecosystems. Whilst no clear definition has yet emerged Erkman states there appear to be three common elements

- *'It is a systematic , comprehensive, integrated view of all the components of the industrial economy and relation with biosphere*
- *It emphasises the biophysical substratum of human activities , the complex patterns of materials flows within and outside the industrial system, in contrast with current approaches that mostly consider the economy in terms of abstract monetary units, or energy lows*
- *It considers technological dynamics i.e. the long-term evolution (technological trajectories) of clusters of key technologies as a crucial (but not exclusive) element for the transition from actual unsustainable industrial system to a viable industrial ecosystem' (Erkman 1997:1-2).*

Graedel and Allenby (1995:9) describe industrial ecology, with reference to manufacturing, as the design of industrial processes and products from the dual perspective of product competitiveness and environmental interactions. The authors expand on this stating;

> *'the concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimise the total materials cycle from virgin material to finished material to component to product to obsolete product and to ultimate disposal. factors to be optimised include resources, energy and capital'*

The anthropogenic use of materials and resources should be one that adheres to Graedel and Allenby's complete cyclicity model. Therefore, a closed loop approach whereby the outputs from one system are inputs into another, rather than the unconstrained dissipating system where materials and energy are degraded, dispersed and ultimately lost to the economic system. Life Cycle Assessment is a fundamental component of industrial ecology whereby the impacts of a product or process are assessed and the design changed to facilitate return materials/energy flows into a closed loop model.

The highly influential paper by Frosch and Gallopoulos (1989) in 'Scientific American' offers the view that it should be possible to develop industrial production methods that more closely echo the operation of a biological ecosystem. The two most immediate applications of this concept are identified by Erkman as firstly, *eco-industrial parks and islands of sustainability* (industrial zones where waste or by-products if one company are used as resources of another). Secondly as *dematerialization-decarbonisation and the service economy* – optimising flows of materials, dematerialising the economy, decreasing the relative carbon content (via shifts in types of energy used) and selling services rather than goods.

2.6.5 Eco-efficiency

The elements of waste management, minimisation, energy efficiency, source reduction and waste exchange can be grouped under the heading of 'eco-efficiency' (reviewed by a range of authors including DeSimone *et al.* 1997; Elkington 1998; von Weizsacker *et al.* 1997). Eco-efficiency is a catch-all term that appears to have been adopted to express the application of the 'produce more from less' or 'use less resources to produce the same amount' philosophies. The eco-efficiency creed has its roots in Malthusian principles, as well as a logical extension of TQM principles but is ultimately 'sold' to business on the basis that it impacts overall profitably by making the production process more cost efficient. The ACBE (1998) state that eco-efficiency (along with environmental management systems and standards) are a necessary requirement in achieving 'sustainable consumption'.

Eco-efficiency was defined by the World Business Council for Sustainable Development and others (as reported by DeSimone *et al.* 1997)

> *'Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing environmental impacts and resource intensity throughout the life cycle' to a level at least in line with the earth's estimated carrying capacity' (WBCSD 1996)*

A range of guides, reports and self help manuals have been produced to assist companies in identifying and managing their wastes (e.g. EPA 1988; ETBP 1997; ETBP 1999). Some of these detail specific 'best practice' examples for companies to emulate (e.g. ETBP 2000; EEO 1995). The UK government and a range of green support groups have produced support material to assist companies in all the areas of corporate environmental management but with the greatest proliferation in environmental auditing, waste minimisation and more recently the broad area of 'eco-efficiency'. Holt and Viney (2000) detail more examples of such support schemes. There is clear evidence of savings that can be achieved through a process of eco-efficiency (which include the broad areas of waste minimisation and energy efficiency), for example CEST 1998; DTi 1992; EA 1997. However in many ways the process of eco-efficiency is an extension of the quality improvement process encapsulated by TQM, a logical process whereby companies minimise the 'cost' associated with production and waste. The recent use of economic instruments (i.e. the landfill tax) seek to externalise the cost of using the assimilative capacity of the natural environment.

In simplistic terms, at an operational level, waste minimisation (being eco-efficient) has tended to be a process whereby a company looked at the input –output transformation process and tried to reduce the absolute amounts of materials consumed and waste by-products produced. Identifying at a broad input/output level the main processes by which waste minimisation could be implemented. As the minimisation of 'easy' targets is reached, normally through better operational controls such as adding cut off switches to pipes, reducing waste heat etc, then the focus will need to switch to more 'difficult' targets. Necessitating a switch to fully transparent identification of the consumption of resources and total environmental impact. However, there is an argument that such a fully transparent approach in order to achieve zero emissions, in light of the law of diminishing returns, is simply not economically viable (Holt *et al.* 2000), or simply impossible for some firms (Holt and Viney 2000).

2.6.6 Life Cycle Assessment

Life Cycle Assessment (LCA) is a decision support tool supplying information on the environmental effects of products. Evaluating the life of a product from conception, design, raw materials extraction, purchasing, production, packaging, distribution and use to disposal at the end of its life. ETBP (2000b) identifies LCA as a process that identifies the material, energy and waste flows associated with a product over its entire life cycle so that the environmental impacts can be considered. It can be used to evaluate the environmental performance of processes, products and services from 'cradle to grave' and identify potential cost savings. It is relevant to most if not all, industrial situations where a product is manufactured or a service is provided.

In essence this technique is an objective process to evaluate the environmental burdens associated with a product, process or activity by identifying and quantifying energy and materials used and wastes released to the environment. It is used to assess the impact of the energy and materials used and waste released. It is also used to evaluate opportunities to improve environmental quality. The assessment includes the entire life cycle of the product, process or activity. From this assessment it will encompass raw materials extraction and processing, manufacturing, transport and distribution, use/re-use/maintenance, recycling and final disposal. Waller (1999) produces a summary of the key life cycle considerations that should be addressed at each stage, with reference to the supply chain. Complete life-cycle assessments should be composed of three separate but interrelated components (UNEP 1996)

- *Life-cycle inventory*: an objective data-based process for quantifying energy and raw material requirements as well as pollutant releases in the form of air emissions, waste water effluents and solid wastes as well as noise pollution throughout a product, process or activity;
- *Life-cycle impact analysis*: a technical, quantitative and/or qualitative process to characterise and assess the effects of the environmental loading identified in the inventory component. The assessment should address all possible effects, such as ecological, human health etc;
- *Life-cycle improvement analysis*: a systematic evaluation of the needs and opportunities to reduce the environmental burden associated with the whole life cycle of the product. This analysis may include both quantitative and qualitative measures of improvements, such as changes in product, process and activity design; raw material use; industrial processing; consumption means and waste management measures.

As discussed by ETBP (2000b) LCA can be used to provide a company with information internally or externally about their own products, or the constituent elements of another product of which their product is a part. The main applications and benefits of LCA are identified as:

- Improving efficiency and costs through eco-efficiency (for example the estimated £50 million savings from Procter & Gamble over a five year period through adoption of an LCA approach to their waste and raw materials consumption);
- Aiding more environmentally responsible product design (SmithKline Beecham used LCA to assess product packaging and as a direct result the company believes it has saved 30000 t/yr. of materials and realised energy savings equivalent to the annual consumption of 3500 households (ENDS1996);
- Assisting in product marketing (Proctor and Gamble were able to use a LCA to refute press claims that a substituted packaging was less environmentally friendly than the original and, did in fact have a decreased total environmental impact than the original at that time ETBP 2000b);
- Aiding the demonstration of environmental performance in response to supply chain pressure (The example of B&Q is posed by ETBP (2000b) where this company reviews the life cycle of key products to set targets for improvement to stimulate environmental performance; and
- Assisting in the compliance with environmental legislation with LCA identifiying potential

breaches of compliance with legislation

The LCA approach is fundamental to a product being awarded an ecolabel, although the recent Regulation (EC) No 1980/2000 has revamped the Ecolabel scheme to include services as well as products. The objective of the Community eco-label award scheme is to '*promote products which have the potential to reduce negative environmental impacts, as compared with the other products in the same product group, thus contributing to the efficient use of resources and a high level of environmental protection*'. This objective is pursued through the provision of guidance and accurate, non-deceptive and scientifically based information to consumers on such products. For the purpose of this Regulation the term 'product 'is taken to include any goods or services, the term 'consumer 'is taken to include professional purchasers. (Regulation EC No. 1980/2000). A range of LCAs have been published by the EU Eco Label scheme [4].

The sphere of influence of environmental issues, i.e. the extent to which a firm/organisations will address perceived environmental responsibilities, has been extended by the LCA concept into the upstream and downstream aspects of a product's life span. The role and responsibility of downstream suppliers and upstream consumers, rather than just the internal operational elements of the production process (i.e. within the 'boundary of the operations function') is a key element of a LCA.

The 1998 ACBE Report to the Government notes the need to move towards sustainable patterns of consumption. ACBE (1998) stated that;

> '*if businesses or government want to change people's behaviour they must provide the products, services, pricing (including financing) and reasons that facilitate people choosing to change. The stimulation of the power of the consumer is the strongest way to drive the move towards sustainability.*

The Government's response to this was a statement that welcomed:

> '*the enhanced stewardship role across the whole lifecycle of products, minimising the environmental impacts during their production phase, their use by customers and their disposal. The Government would wish to reflect this approach in the development of policies and measures that influence product life cycles*' (ACBE 1998:51)

However, the concept of LCA is not without it's critics as noted by Davis (1998:5). He states '*LCA encountered more problems than it solved... A backlash of criticisms that it was too*

[4] Further details are available at http://europa.eu.int/comm/environmental/ecolabel/index.htm.

expensive and too time consuming'. Yet, Davis (1998) also notes that the work of the International Standards Organisation (ISO) to standardise LCA methods has done much to initiate a renaissance it. The LCA tool is now recognised as one tool amongst many, rather than the ultimate solution, as practitioners have grown to understand the its strengths and weaknesses. Some practitioners are trying to bridge the gap between total cost accounting and LCA, and developing tools that form part of a process of lifecycle management. ComEd, a US electricity company, claims lifecycle management has saved them $35 million and yielded numerous pollution prevention opportunities. When specifying a product ComED requires employees to take a long term evaluative approach (examining aspects such as transportation, storage, spills, accidents and other risks) since they estimate that 80% of ownership costs for a product are determined by the decisions made at the acquisition stage (Davies 1998:29). Some could argue that perhaps the most influential element of LCA has been the promotion of 'lifecycle thinking', which now underpins much of the resource management and eco-efficiency literature.

The data demands of LCA or even lifecycle thinking require manufacturers to interview their suppliers. A research project by three largest US automakers to examine the supply chain for a generic vehicle has taken the group 2 years to define, with a LCA on over 20,000 parts posing a huge task (Davies 1998:35). Fava (cited in Davies 1998: 36) believes that organisations need to adopt a systems perspective, looking at ways to improve efficiency along the whole of the supply chain, in order for an ethic of product stewardship to emerge.

There has been criticism of the EU for not using LCA as a basis for its environmental policies. For instance, in the cases of the recent EU Directive that requires electronics companies to take back end-of –life equipment, manufacturers believe that end of life disposal represents only a very small percentage of the total lifecycle impact of electronic equipment (Davies 1998:19). A representative from Panasonic estimates that 85-95% of their products' total environmental impact comes from energy consumption.

The misapplication of LCA, especially in its early days, tended to occur when it was used to make comparative claims. Jim Fava of Roy F. Weston Consulting, states

> *'today, most of the LCA applications are internal. The focus ...should be to provide companies with strategic information to focus their resources towards areas where reductions in energy and materials, or environmental releases, can be made and guide in the development and evaluation of existing or new products...LCA enables*

companies to understand the environment tradeoffs between materials or processes' (in Davies 1998:25).

2.6.7 Design for the Environment

The key to many successful environmental management strategies is the design of environmentally responsible, or less environmentally damaging, products and services without unduly compromising function, quality, cost and other considerations. There is a growing field of work on Design for the Environment (DFE), which is a collective term that includes lifecycle design, ecodesign, and environmentally conscious design.

Shelton (1996) defines DFE as a technology management activity whose goal is to align product development activities in order to capture external and internal environmental considerations. Lenox and Ehrenfeld (1997) note that superior product design may help firms prevent pollution, reduce material throughput and reduce environmental, impacts of products during and after consumption. Design changes may produce financial benefits through the manufacturing process, improve customer satisfaction and lighten the environmental regulatory burden.

The goal of DFE is to consider the complete product life cycle when designing environmental aspects into a product or process (Sarkis 1998). LCA does have a role to play in this DFE process but some practitioners such as Motorola, Battelle and Volvo use lifecycle thinking and a variety of profiling mechanisms rather than a full LCA. Using a full LCA every time a new product is designed is time consuming and expensive. Volvo for instance, use a lifecycle score approach where they have used results from past LCAs to develop an Environmental Priority Strategies Tool (in Cutter 1998:30), to score new designs as part of the decision making process.

Sarkis (1998) states that DFE involves considering the:

- Types of materials used in the manufacture of the product;
- Recyclability and reusability capabilities of the materials;
- Long term impact on the environment of the materials;
- Amount of energy (and efficiency) required for the product's manufacture and assembly;
- Capability for easy disassembly for remanufacturing;

- Considerations of the product's design to include remanufacturing characteristics; and
- Considerations of the product's design to include durability and disposal characteristics.

Thus the DFE concept supports the philosophy that environmental factors need to be integrated into the early design of any product or process. Sarkis (1998) further summarises the characteristics of DFE as illustrated in table 2.2.

Table 2.2: Principles of design for the environment (adapted from Sarkis 1998).

Recyclability, reusability & remanufacture	-Relationship between the three defined by the amount of treatment required. -minimal treatment associated with reuse -large amount of treatment results in recycling -remanufacture falls between the two (typically related to economic cost) -design for reuse typically focuses on the overall product rather than components
Remanufacturing	-refers to the design of the product with respect to repair, rework, or refurbishment of components and equipment to be held in inventory for external sale or internal reuse -typically identical groups of products/components held in batches, completely disassembled, and cleaned before being reassembled (Lund, 1983)
Disassembly	-focuses on designing a product that may be dismantled for recycling, remanufacturing or reuse purposes - Technological and design characteristics, as well as appropriate ands specialised equipment and processes will be required.
Disposal	- includes considerations of materials and transportation requirements of materials that will be used -issues of biodegradability and toxicity are an important element of the design phase

The involvement of suppliers in the design process can be a critical factor in incorporating eco-criteria. Scotsman Industries is one of the World's largest manufacturers of ice making equipment and was required to redesign equipment without CFCs in 1991 after they were banned. The Director of Purchasing at Scotsman stated that '*we cannot engineer every component.. We don't have the knowledge. The expense of hiring such talent would be enormous and drive product costs to the point of uncompetitiveness*' (in Carbone 1995:36). Therefore Scotsman tapped into their supplier's capabilities by undertaking a four-stage product development process that relied heavily upon supplier involvement, to redesign their CFC products.

Lenox and Ehrenfeld note the existence of communicative linkages or 'communication web' (after Allen 1971; Brown and Eisenhardt 1995; Fujimoto 1994) as being important in superior product development capability. Allen (1971) notes that product development capability derives from communication between team members and outsiders, which in Scotsman's case were their suppliers. Recent work discussed by Lenox and Ehrenfeld (1999), identifies both the existence of such communication and more specifically the quality of content, as being important.

Packaging can account for over 30% of the municipal solid waste stream and an effective green packaging programme is essential within any environmental programme (Min and Galle 1996). Packaging waste arises in both the commercial and household sectors, with the DoE estimating that 63% of all packaging waste is from households. Industrial packaging waste arises from secondary packaging (used to group products together) and tertiary (transit waste). The main forms of commercial waste are plastics, (drums, crates and film wrapping), metal (drums) and fibreboard (boxes and crates). Whilst primary packaging consists of paper, fibreboard, plastic bottles, cartons, films, glass bottles, aluminium and steel cans used at the individual product level.

In an effort to reduce waste in landfill there have been ranges of programmes that are designed to reflect the 'true' cost of waste disposal. Examples include the 'Landfill Tax' in UK, the UK Packaging Waste Regulations (Anderson *et al.* 1999), and the EU Directive on Packaging and Packaging Waste and the 1991 German Green Dot programme that requires shippers to take full responsibility for disposal of transport packaging. In Wisconsin and Toronto there is a ban upon the disposal of expanded polystyrene and wooden pallets (Andel 1993).

In the 1990's a range of companies introduced recycled and reusable packaging including Pepsi, Du Pont, Coca-Cola, and Proctor and Gamble (Stilwell *et al.* 1991). Baxter's, a global distributor of health care products, set a goal of reducing the average weight of packaging by 15% through innovations such as the development, in association with a supplier, of a lighter stronger fabric container. It is estimated that Baxters have saved 40 million lbs of packaging and $38 million costs over the last five years through this waste reduction programme (Anon 1997).

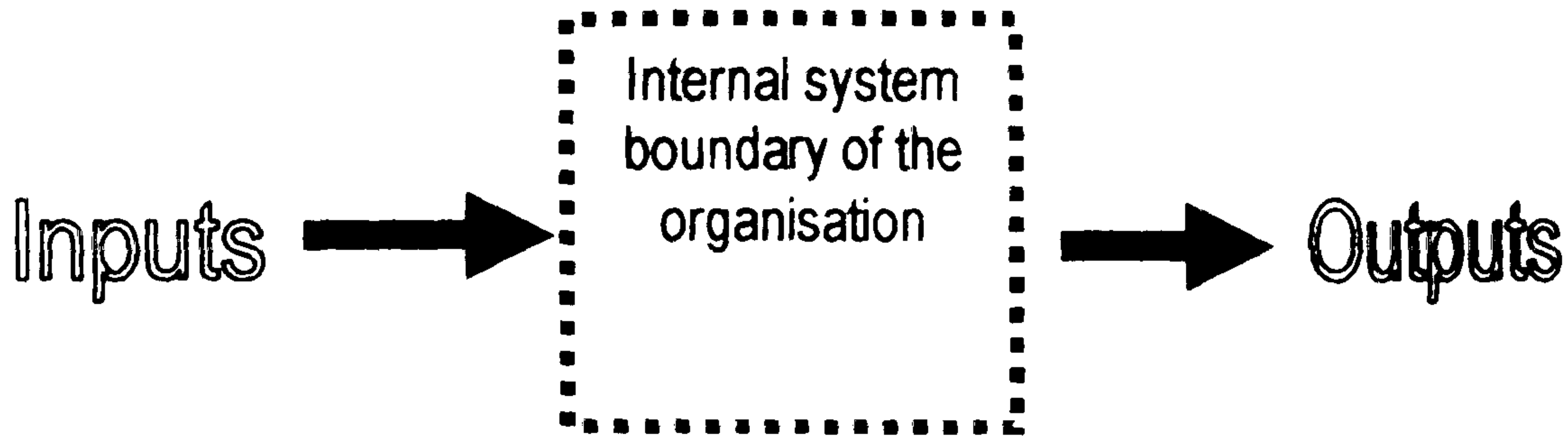
In the UK the Producer Responsibility Obligations (Packaging Waste) came into force in 1997 companies can either make their own arrangements for the recovery/recycling of the packaged waste they generate or join a compliance (collective) scheme organised by a third party which will discharge the companies obligations. A key element of the 1997 regulations was that it did not require a company to recover or recycle its own actual packaging but an equivalent tonnage of packaging waste (Anderson *et al.* 1999). Anderson *et al.* (1999) estimated that approximately 25% of all packaging waste was already being recovered prior to the introduction of the packaging regulations, with commercial recovery or recycling relatively more successful than household recovery.

Packaging is a dominant source reduction target with many buyers specifying returnable or reusable packaging, specifying that packaging should be made from recycled materials or designing packaging systems that reduce the amount of materials used (Stundza 1995). Packaging waste is a key element of a reverse logistics programme for waste management in the UK. However the packaging regulations do not currently force a reverse logistics programme on individual firms to return their **own** packaging, particularly primary packaging which passes into the hands of the consumer. Some firms do use backload transports to return their secondary and tertiary packaging. The design of packaging is also an important element of the eco-design process discussed earlier.

2.7 Summary

This chapter mostly focuses on the internal aspects of environmental management, within the environmental operations management sphere. The early practical tools and techniques used to green companies were concerned with addressing issues of compliance, managing operational processes and communicating to external stakeholders through environmental policies an organisation's environmental management activities.

However, there is now a process of extending environmentalism outside the boundaries of the organisation. Examples include companies conducting life cycle assessments to identify where the external environmental impacts of their products from raw material use through to disposal, selecting less damaging products or materials through purchasing and recovering materials through waste management. The movement of environmentalism outside the internal boundaries of a firm into the demand side and supply side of the transformation process could be classified as the 'extension of corporate environmentalism ', as illustrated in figure 2.3



Identification & Assessment of Environmental Impacts

e.g. Environmental Reviews, LCA, EIA,

Management or Policy Response

e.g. Environmental Policy, Eco-design, Supplier Selection, Management Systems, Environmental Standards

Key
Functional Areas of Corporate Environmentalism
Practical Response
Intra-focussed organisational response ←——
Extended environmentalism outside traditional boundary of firm ←-----

Figure 2.3: Practical environmental management in organisations

It is the extension of environmentalism into the supply chain that is the focus of this research incorporating internal environmental operational practices, upstream and downstream environmental management activities.

APPENDIX 3: ANECDOTAL EXAMPLES OF GREEN SUPPLY CHAIN MANAGEMENT PRACTICES

Organisation	Notes
Advanced Micro Devices Trowbridge (2001)	Supplies integrated circuits for computers and communication markets and produces microprocessors. Employees 14,400 people worldwide and had revenue of $3.9 billion in 2001. Produces a separate environmental health and safety report. All sites have or are seeking ISO14001 accreditation. Design for the environment focus in manufacturing materials, tool selection and packaging. Is affected by take back issues and product stewardship and responds to many requests from OEMs each year. Currently working with a variety of industry groups to determine the kinds of information needed. Have a requirement to develop pollution prevention and resource conservation plans at each site. Whilst there are no specific green purchasing policy that have a series of more informal guidelines. Work with a variety of external groups. Self-assessment questionnaires sent to high-risk suppliers. Suppliers are involved in joint R&D of environmentally friendly technology and processes
Allergan Messelbeck & Whaley (1999)	Allergan develops technologies for eye disorders, skin disorders, pain relief, and movement disorders and cancer treatments. Have 8000 employees globally. Has an environmental product design programme that considers environmental and heath and safety effects of raw materials suppliers, manufacturing facilities, distribution partners and customers. Develops environmental impact assessment for each new product. R&D looks to avoiding toxic chemicals where possible, minimising hazardous materials an optimising the recyclability of product waste. Key element of strategy is to foster business agreements with organisations with effective health and safety policies. They create relationships with suppliers in the expectation that they will strive to meet/ exceed company guidelines for preferred provider status. If supplier has accredited to ISO14001 audit not needed. Currently undertaking customer education programme to encourage purchasers (the Health Care deliveries) to preferentially purchase from ISO certified suppliers
Ametek Ottman (1998)	Paoli Pennsylvania manufacturers of expanded polypropylene. Developed an integrated programme for collecting and recycling the foam cushioning used by its customer (Ethan Allen). Amtek pays Ethan Allen 10cents per pound of material shipped back for recycling. The UPS authorised Return service (developed in 1990) for Canon's toner cartridge retrieval programme is used
AT & T Dambach and Allenby (1995) Stock (1998)	Telecommunications. The Networks Systems Division saved $100 million in the 19 months it had been operating a reverse logistics programme for its telephone switching equipment.

Organisation	Notes
B&Q Barry (1996), Hutchinson (1997) Knight (1995)	Large UK based DIY firm. Supplier Environmental Audit sent to all suppliers in 1991. Found only 8% had an environmental policy, 29% had taken no environmental action at all and 25% did not complete the questionnaire. Communication and awareness programme was developed involving 12 seminars, regular briefings for buyers and individual written reports for each supplier. Reports formed the basis of the grading of the suppliers, based on level of commitment rather than level of risk. By 1993 only 35% of B&Q's suppliers were at the environmental equivalent of grade C or above. In 1994 the board decided to add a commercial dimension by setting two targets. All grade F suppliers had to achieve grade C or above within 6 months and all grades D or E had to achieve a grade C within 11 months. To achieve grade C suppliers had to produce a written policy identifying key issues and make a firm commitment to dealing with them. A support programme was provided for suppliers with 100-clinics held in 1994. A monthly statement of progress was produced for each supplier. By the end of 1994 94% suppliers had reached their targets. Ten companies that failed were de-listed but the rest that failed were given another chance and have now reached a satisfactory standard.
BiE (nd) Business in the Environment	Business in the Environment Support Agency Developed a CD-ROM of their corporate engagement index, answering questions on their environmental management activities. Information is used to relate supplier to sector, group and sample average. Used with targeted suppliers – high risk, close relationship or large contracts. Tested with TXU Europe and their suppliers.
Corenso United Oy Ltd. Linnanen & Halme (1996)	Jointly owned by two major Finnish pulp and paper companies, produces coreboard An example of an 'industrial network'. Company specialises in the reuse of difficult composite materials containing layers of plastic, aluminium and wood fibre. Has a seven year contract with German paper collector DSD to annually utilise 70,000 tonnes of the German liquid packaging board waste
Crane and Company Ottman (1998)	Stationary makers Dalton, Massachusetts. Recycle old currency and denim scraps (from Levi Strauss) into stationary and cotton-rag paper respectively
Dofasco Steele (1996)	Fully integrated mill based in Canada. Employs 7300 people at base in Hamilton. Has clear environmental policy that endorses principals of reduction, recycling and reuse. Number of energy efficiency programmes, process redesign activities. Part of the Steel Recycling Institute to develop and assist in a recycling infrastructure for steel cans
Dell Computers Yang and Sieben (2001)	Has a committed environmental policy which details aspects such as reducing transportation and warehousing costs by shipping directly to the customer, pollution prevention and eco-efficiency programmes. Encourages suppliers to use recyclable packaging. Asset recovery programme were large scale customers can dispose of outdated equipment. Dell picks up and delivers outdated equipment to collection partners for reuse or recycling.
Eastman Kodak Ottman (1998)	Kodak fun saver one time use camera. Consumers return the whole camera for processing, the photofinishers are encouraged to return the camera to Kodak for recycling and reuse. The company reimburses

Organisation	Notes
	them for each one returned and pays shipping costs. By late 1996 more than 80 million cameras had been returned.
Herman Miller Kroon and Virijens (1994)	Claims to have saved over $600,000 in two years using returnable packaging material for steel shelves
Hewlett-Packard Yang and Sieben (2001)	Has been award German Blue Angel for many of it's computers. EHS information provided on each computer. Extensive programme of eco-efficiency and pollution prevention initiatives. Have incorporate environmental aspects into the design procedures. Has supplier audit system in place where suppliers are asked to reduce environmental hazards in manufacturing and design energy efficiency into products. Suppliers are expected to label products that contain regulated substances and use the minimum amount of packaging. Has instigated a reusable packaging system allowing HP to ship in bulk and reduce use of pallets, shrink wrap etc. Instigated end of life returns programmes. HP reuses or recycles 3.5 million lbs. materials each month.
IBM Yang and Sieben (2001)	Product stewardship programme – including a global asset recovery service to co-ordinate the recycling of manufacturing scrap and returns. Detailed waste management, pollution prevention and energy management programmes are in place
Intel Anon (1997)	Transport media group developed within purchasing, with a focus on leverage creativity and competitiveness of suppliers to minimise bulk and enhance recyclability. Set performance requirements in terms of fragility and shock levels, with a stated view that 'price' is secondary in their considerations of supplier. They reached their target of 30% reduction of the plastics used to ship semi-conductors in 1996
J Sainsbury plc BiE (1997:14-15)	World-wide retailer, including Sainsbury's supermarkets. Practising Integrated Crop Management- an environmentally responsible approach to crop production. ICM programme began in 1991 developing an umbrella policy circulated to all suppliers, began hosting supplier product group meetings and developed ICM protocols for different products, verified by self auditing and Sainsbury's technologists
John Deere Co. Ottman (1998), Kroon and Virjens (1994)	Horicon, Wisconsin. Developed reusable shipping crates – provides them to its suppliers free of charge for shipping parts to their farm assembly plants with estimated savings of $1.5 million per year. Invested $20 million in the returnable container programme with it's suppliers.
MCC Van Hoek (1999)	Developed the Smart car. Subsidiary of Mercedes The Smart are is designed to use product upgrades and adjustments to develop enduring customer contact. Product's life cycle can be extended by the add on modules and replacements, thus reducing waste
National Power BiE (1997:12-13)	£1.5 billion fuel purchased each year, £500 million on goods and services. Plans for reverse supply chain making original supplier take back equipment Procurement policy based on environmental policy with key objectives of: Developing a framework for integrating environmental issues into purchasing

Organisation	Notes
	Ensure suppliers/contractors are not causing unacceptable environmental impacts Encourage constituents parts of supply chain to improve performance For example: boiler chemical task group (including suppliers) produced series of improvements that reduced the environmental risk and the overall cost of hazardous waste management of the chemical concerned.
Nissan UK BiE (1997:6-7)	Japanese car manufacturer. By 1997 employed 4000 people and produced 215,000 vehicles. Supplier base of 200 European suppliers Philosophy of working with suppliers by addressing commercial issues, sharing ideas, resources and benefits to both parties. Plastic parts made from recycled materials, recovered from sources such as plastic bumpers All plastics greater >100g coded for recycling suppliers asked to make process improvements similar to the pollution prevention/ eco-efficiency one made by Nissan 'where appropriate' Logistical milk round system from European and UK suppliers – components transported together to Nissan rather than individually (saving an estimated 15 million road miles per year) Since 1992 European suppliers required to use returnable packaging developed by Nissan (used for imported components from Japan also) with 95% of components arriving in returnable packaging – annual saving of £95,500 with start up cost £127,800.
Nortel BiE (1997:8-9)	Telecommunications company, operating in more than 90 countries, employing over 60,000 people Environmental responsibility based upon principle of product stewardship from concept to disposal. Removed CFC-113 solvents from manufacturing worldwide in 1992, initiating the Environmental Life Cycle programme. Aims to sharing experiences with suppliers, customers and other organisations to build networks and long term relationships 1996 Nortel Monkstown (the R&D and manufacturing facility in Northern Ireland) began a 'greening' its supply base. Undertook survey to assess an environmental score (600 suppliers) Invited top 100 invited to on-site seminars, scoring system explained and suppliers told the environmental score would be added to selection criteria for supplier rating Nortel asked for suggestions of how it could assist suppliers (resulting partially in programme with ARENA Network to assist smaller suppliers) Plans to streamline supplier base but also noted logical outcome of the green supply chain process had been a reduction in SMEs as most were 'unwilling or unable' to meet demand for demonstrable environmental probity.
Patagonia Carter and Carter (1998)	Outdoor clothing manufacturer. Buyers identified sources of environmental friendly raw materials and then worked with engineering to design fleece outer wear
Pilkington BiE (1997:10-11)	An international glass company with 39,000 employees' world-wide, producing glass for building and transport markets, energy and electronics sector. Began process of involving suppliers as part of a regional effort to improve the environment initiated by the North West

Organisation	Notes
	Business Leadership Team (NWBLT), 30 CEOs from major companies in the region. Each company had completed environmental policies and agreed targets, which include the requirements to conduct local supplier seminars by the end of 1996 to assist in influencing local suppliers to take environmental action. Each NWBLT member encouraged to assist 10 SME's. Pilkington invited 20 of largest local suppliers to a seminar to demonstrate business case for environmental management and identify ways to work together and gain commitment. Pilkington states can clearly see benefits to involving suppliers in discussions over environmental issues including: more robust life cycle control; less risk of being associated with an environmental accident caused by smaller supplier; improved image in assisting SMEs to obtain advice and improve performance.
R Frazier Ltd BiE (1997:20-21)	Asset Management. Manages companies' obsolete and excess products, recycles by dismantling as well as testing and repairing for reuse. Shares revenue from resale with clients as well as finding world-wide buyers for its reused products, earning a higher yield than traditional materials recycling alone. Provides in house refurbishment to make recovered telephones suitable for use overseas
Safety Kleen Ottman (1998)	Chicago and Canada. Largest re-refined oil supplier in USA Tapped into network of over 125,000 service stations, car dealerships and industrial centres across US to collect used motor oil and recycle it into a product known as 'America's Choice
Safeways Christensen (2002)	Currently recovers 90K tonnes cardboard per annum. Uses Safeway vehicles to collect from suppliers, optimising costs and allowing transport planning. Also chooses rail networks saving 1.8 million road miles per year. Uses returnable packaging. Has one of the largest European fleets of compressed natural gas fuelled vehicles.
SC Johnson Ottman (1998)	Company holds annual Supplier Days where representatives brief suppliers of ingredients, packaging and other inputs on the corporation's environment; objectives and progress and educate them on key development s in LCA, product stewardship and other green product development tools
Schroeder Ottman (1998)	St Paul Minnesota. Refillable milk containers returned to the SuperAmerica chain of stores. Can be refilled 30-40 times and then came be recycled into lawn furniture and other products
Shadow Lake Inc. Ottman (1998)	Citra-Solv cleaning product made from the orange peels left over from the juice making process.
Shaw Industries Rondinelli and Berry (1998)	Largest tufted carpet manufacturer in the world. Over 30,000 employees, exporting around world from its HQ in USA. Have addressed entire value chain to enhance competitive strategy. Integrated environmental and strategic objectives into operational and management practices adding value to customer and efficiencies to the organisation. Reduction of wastes to landfill is an integral part of its value chain, examples include: Shaw's engineers developed a way to use carpet fibre to reinforce concrete, developed a carpet material made from recycled soda and milk containers and a variety of internal eco-efficiency measures. By 1997 Shaw was recycling 80% of its solid manufacturing wastes. Shaw asked

Organisation	Notes
	suppliers to reduce the volatile organic compound 4-PCH by 30%. When suppliers suggested this was not possible there was the suggestion that new suppliers would be found. Within 90 days suppliers had redesigned the product with 70% less and Shaw shared with their competitors the techniques for reducing VOC emissions
Shields Special Metals Ltd BiE (1997:18-19)	A medium sized enterprise that recycles precious and rare metals from electronic and electromechanical equipment at end of product's life span. Vendors assessed in compliance with company's 'Quality Assurance Purchasing Policy' which includes a combined quality and environmental vendor assessment questionnaire. Companies audited with regard to potential environmental impacts and answers to specific questions carefully examined. Shields states that the vendor audits are carried out in a spirit of co-operation and seek common ground for compliance with regulations and environmental protection. Smaller companies are assisted through provision of guidance and practical advice on implementation
Target Stores Muller (1991)	Distribution centres ship merchandise stretch wrapped on pallets. The used plastic is collected, delivered to a recycler in Kentucky who then sells it to a firm that uses the plastics to make plastic bags, which are subsequently sold in Target stores
United Utilities (North West Water) Deans (1999) Webb (2000)	Majority of purchasing responsibility of the Vertex data group, the total spend in United Utilities is £47 million per year. Northwest Water published environmental strategy in 1997. Commitment to developing an environmental purchasing policy which would include environmental criteria monitoring the effectiveness of suppliers environmental policies communicating policy to partners and suppliers Developing an environmental management system Set up green procurement working group and specialised product specific subgroups. Current subgroups, which include specifiers, buyers, specialists and advisors, are paper, tyre and chlorine United Utilities is involved in a trial for the Dti to use ISO14031 as a way of assessing supplier performance via data collection for the standard. Collecting environmental performance data as indicated by the requirements of the standards to assess whether accreditation to the standard can by used as a supplier indicator for 'green supply' chain programmes
Van Hecke Catering Creamer and van Leenders (2000)	Founded in 1963 this is the largest contract caterer in the Netherlands with a market share of 34%, with a turnover of 300 millions euros per year. Employees 6500 people. Launched a chain-orientated environmental policy in the early 1990s driven by customer complaints. Undertook a survey in the Food Services department of possible areas of environmental improvement. Main focus taken was separation of waste at source. Identified that the lion share of residual waste reductions would have to be made in consultation with suppliers. Five major suppliers approached. Asked suppliers of coffee and soap to switch to reusable bulk packaging, the producers of milk and desserts that supplied individual portion packaging to change to polystyrene

Organisation	Notes
	packaging. Meat supplier was asked to use monomaterials instead of composite plastics. Initially refused to commit, but Van Hecke able to draw up a declaration of intent with catering sector as a whole, through the trade association. Still a problem with suppliers – many did eventually sign declaration of intent but only a few of the proposed alterations have been made. Alternative suppliers were found in some cases. 125 restaurants involved in recycling scheme with 75% total waste being recycled
Wellman Inc Ottman (1998)	Shrewsbury New Jersey. Largest recycler of PET plastic bottles Developed Fortrel EcoSpun fibre, made from 100% recycled soda bottles and used by mills that turn it into fabric. Used in sportswear, sleeping bags, coats, toys and jumpers by companies such as Patagonia, Levi Strauss and Eastern Mountain Sports.
Xerox Corp Ottman (1998) McIntyre *et al.* (1998)	Saved $200 million in materials and parts in less than 5 years by remanufacturing their photocopiers, using the same assembly line to produce manufactured as well as remanufactured machines (Ottman 1998). Environmental initiatives in the Xerox integrated supply chain include reduction and reuse of packaging, return transport flows of used, unserviceable machines, parts, packaging and pallets. Also reverse logistics of empty toner bottles and print cartridges. Developed an environmental performance metric which concentrates on energy consumed, materials intensity and pollutants produced at each stage. Their manufacturing sites are accredited to a mixture of EMAS and ISO14000. They have a supplier environmental programme that works with suppliers (McIntyre *et al.* 1998).

APPENDIX 4: DETERMINING SAMPLE SIZE

Possible respondents identified in CIPS database

(a) Total number of CIPS Members (August 2002) = 25,800

(b) Number of members who meet the eligibility screening criteria = 2794

(c) Number of organisations represented in (b) = 1457

Therefore 1457 possible respondents were identified that met the eligibility criteria, and excluding multiple respondents from the same organisation.

Minimum sample size required

The sample selected from the CIPS databases was based on a non-probability sample design using 'judgement criteria' (Ryan 1995:174) where the sample is based upon what the researcher feels is representative.

Ryan (1995:179) notes that the minimum sample size needed can be calculated by the equation:

$$N = \frac{z^2Pq}{B^2} \qquad \frac{(1.96)^2\,(0.5)\,(0.5)}{0.03^{\,2}} = 1067.11$$

where n = sample size

P = population proportion or estimate. (In those instances where there is no a priori inclination then the value of P = 0.5 is often used (Ryan 1995:178))

q = P-1

B = allowable error (The allowable error by convention is normally estimated as 3 percent or 0.03 (Ryan, 1995:178))

Z = z score based on desired confidence level (When seeking to work to a confidence level of plus or minus 2.5% of the mean the z value is customarily 1.96 (Ryan 1995:177))

Using the 'default' values of B, Z and P the equation above suggests that the minimum number of questionnaires to be distributed was 1067. Many public opinion surveys use a default sample size of 1100 by rounded up the nearest 100 from 1067 (Lohr 1999). *Therefore suggested minimum number of questionnaires to be distributed was 1100*

MIDDLESEX UNIVERSITY

APPENDIX 5: PILOT STUDY VERSION OF QUESTIONNAIRE

Greening the Supply Chain through Purchasing and Logistics

A RESEARCH STUDY

Chartered Institute of Purchasing and Supply

&

Middlesex University Business School
Centre for Interdisciplinary Strategic Management Research

All replies will be treated in the strictest confidence.

Thank you in advance for your co-operation and participation in this study. At the conclusion of the study we would like to send you an Executive Summary of the results. Please provide your name and address below. Otherwise please feel free to remain anonymous.

Name: ______________________

Position: ______________________

Company Address: ______________________

____

____

Please return the questionnaire to us by 30th October 2002

Please use the enclosed SAE to return your questionnaire to Chartered Institute of Purchasing and Supply, Easton House, Easton on the Hill, Stamford Lincolnshire PE9 3NZ

SECTION 1: COMPANY INFORMATION

1. **Please indicate the principal activity of your company** *(Please tick all that are appropriate*

- ☐ Public/ Voluntary Voluntary Organisation
- ☐ Private Sector Commercial Company

- ☐ Service
- ☐ Manufacturing
- ☐ Mixed Service & manufacturing
- ☐ Construction
- ☐ Transport & Logistics
- ☐ Retail/ Wholesale

2. **Please describe in words to type of organisation you work for (e.g. it's main business/ service activities)**

____

____

3. **Please describe the nature of your 'customers'** *please tick one box*

- ☐ We supply goods or services to other organisations or businesses
- ☐ We supply goods or services to individual consumers (i.e. the general public)
- ☐ We supply goods and services to both individual consumers and to other businesses

4. **Is your company?**

- ☐ New Venture
- ☐ UK independent
- ☐ UK Group
- ☐ Joint Venture
- ☐ Global/overseas Group - Please note nationality of parent company............

5. **How many full time employees are there in your company/ site in the UK?**

☐ 1	☐ 50-99	☐ 750+
☐ 2-4	☐ 100-199	☐ 1000+
☐ 5-9	☐ 200-249	If possible please indicate actual number of
☐ 10-19	☐ 250-499	employees ....
☐ 20-49	☐ 500+	

6. **Please describe the way your organisation is structured**

☐ Main HQ with subsidiary sites (controlled by HQ*). When answering questions in sections 2 – 5 please respond with reference to the policy and practice in operation at the main HQ*

☐ Devolved sites with independent authority to control purchasing and supply chain matters. *When answering questions in sections 2- 5 please respond with reference to the policy and practice in operation at the devolved site at which you work*

☐ Single site

☐ Franchise organisation. *When answering questions in sections 2 – 5 please respond with* *reference to the policy and practice in operation at the individual franchise where you work*

7. **What is the total turnover of your UK company/ organisation or subsidiary last year?**

____

SECTION 2: OPERATING ENVIRONMENT AND ROLE OF ENVIRONMENTAL ISSUES

8. **How important do you think the management of environmental issues, such as pollution, conservation, waste management, is to your organisation?** *Please tick one box*

☐ Very important ☐ Of moderate importance
Of slight importance ☐ Not important at all

9. **Do you think that the importance of environmental issues to your company in the next five years will ....?** *(Please tick one box)*

Increase ☐ Decrease ☐ Stay the same

10. **Please name the <u>main departments/organisational units</u> involved in policy making, practical implementation and monitoring of environmental management activities**

Examples of departments or organisational units could include – Safety, Health and Environment, production and operations, PR and Marketing, Engineering, Facilities Management, Legal department, Quality Unit, Purchasing Department, Logistics and Transport, Executive Committee/ Board or other named departments in your organisation

	Key departments involved in these activities
Policy Making on Environmental Issues	
Implementation of practical environmental management activities	
Monitoring and assessment of environmental management and impacts	

SECTION 3: DRIVERS OF CHANGE AND STRATEGIC RESPONSE

11. **Generally speaking which of the following factors <u>have driven changes</u> in the way your organisation <u>manages its environmental impacts and addresses environmental issues?</u>** *(Please indicate the extent to which each factor has affected your organisation)* If not applicable (for instance for some service firms and the voluntary sector please indicate by writing N/A)

Not at all	To a small extent	To a moderate extent	To a great extent	To a very great extent
1	2	3	4	5

		Not at all ....v. great extent
Legislation	In order to comply with current UK government environmental regulations	1 2 3 4 5
	To comply with current EU environmental legislation	1 2 3 4 5
	To address forthcoming environmental legislation	1 2 3 4 5
	In order to pre-empt *possible* legislation in the future	1 2 3 4 5
Societal Pressure	Due to public opinion in the local area	1 2 3 4 5
	Due to societal expectation/ public opinion in the UK	1 2 3 4 5
	Due to societal expectation/ public opinion internationally	1 2 3 4 5
	Pressure from green action groups such as Greenpeace	1 2 3 4 5
	To maintain or present an image of an environmentally or socially responsible organisation	1 2 3 4 5
Professional & Industrial Bodies	Pressure from professional bodies, trade associations	1 2 3 4 5
	Pressure from the Trade Unions	1 2 3 4 5
Financial Factors	Pressure from shareholders and investors	1 2 3 4 5
	Pressure from Insurance Industry	1 2 3 4 5
	In order to achieve operational cost savings	1 2 3 4 5
Supply Chain Factors	Required to by a company you supply to	1 2 3 4 5
	General pressure or encouragement from businesses you supply goods and services to	1 2 3 4 5
	General pressure from individual consumers/ service users	1 2 3 4 5
Internal Factors	Pressure from employees	1 2 3 4 5
	The CEO (or equivalent) is a committed to environmental improvement	1 2 3 4 5

	Environmental responsibility is part of the of the organisational culture of our firm	1 2 3 4 5

Not at all.......v. great extent

Competitive Factors	Provides new profit opportunities in the market	1 2 3 4 5
	In order to keep up with competitors	1 2 3 4 5
	In order to perform better than our competitors	1 2 3 4 5
Risk	In order to reduce the health and safety risk associated with our goods, services and operational practices	1 2 3 4 5
	In order to reduce the health and safety risk associated with the disposal of our products or materials we use at the end of their lifecycle	1 2 3 4 5
	In order to reduce the public's perceived risk associated with our company'	1 2 3 4 5
Other Factors? *Please specify*		1 2 3 4 5
		1 2 3 4 5

12. **In your opinion what is the overall environmental risk and impact associated with your organisation**

- ❑ No risk & low impact
- ❑ Medium risk and impact
- ❑ High Risk – stringent health and safety guidelines necessary
- ❑ Extreme Risk – failure of health and safety could lead to severe environmental impacts or danger to the workforce

13. **Which of the following statements most accurately describes your organisation's environmental policy?** *(Please tick one box)*

- ❑ We have a formal environmental policy and guidelines for dealing with environmental issues *(go to Q.14)*

- ❑ We have primarily an informal or unwritten environmental policy and guidelines *(go to Q15)*

- ❑ We have no specific environmental policy or guidelines *(go to Q15)*

14. **If you have a <u>formal written</u> environmental policy please indicate approximately how long you have had such a policy**

- ❑ Less than 1 year
- ❑ 1-3 years
- ❑ 4-5 years
- ❑ 5 –10 years
- ❑ 10 years +

SECTION 4: GENERAL PURCHASING AND LOGISTICS

15. How many SUPPLIERS providing goods and services to your organisation) do you have?

- ☐ 1 ☐ 10-49 ☐ 200-299 ☐ 1000+
- ☐ 2-4 ☐ 50-99 ☐ 300-500 ☐ 2000+
- ☐ 5-9 ☐ 100-199 ☐ 500 + ☐ 5000

16. How many CUSTOMERS (organisations or companies) do you provide goods or services for?

- ☐ 1 ☐ 50-99 ☐ 750-999
- ☐ 2-4 ☐ 100-199 ☐ over 1000
- ☐ 5-9 ☐ 200-249 ☐ over 2500
- ☐ 10-19 ☐ 250-499 ☐ over 5000
- ☐ 20-49 ☐ 500-749 ☐ Not Applicable – General Public

17. Is your organisation CRITICALLY dependent upon a small number of suppliers (i.e. could not continue with your operations without receiving their goods and services)

☐ Yes – We have a few key suppliers whose goods and services are essential to our operations

☐ Yes – We have a few critical suppliers but there are other firms/organisations we could use if they were to no longer supply to us

☐ No – Each one of our suppliers could be replaced if we really had to

18. Approximately what percentage of your organisation's budget/ turnover do purchased goods/services represent? *please tick one box*

- ☐ Less than 25%
- ☐ 25-50 %
- ☐ 50-75%
- ☐ 80-100%
- ☐ do not know

SECTION 5: GREENING THE SUPPLY CHAIN

19. Which of the following actions does your organisation undertake? *Please indicate level of response by your organisation by placing a tick in each relevant column*

- Yes/ Do at Present
- No/ Do not do or consider at present
- Intend to in next 12 months

❖

Green Procurement and Logistics Policy	**Yes/ Do**	**No/ Don't**	**Intend to**
We have a **formal** policy on green procurement/ purchasing			
We have a **formal** policy on green logistics/transport			
We have green purchasing or logistics **guidelines** that recommend the environment is considered			
We are bound by external purchasing directives (e.g. the EC Procurement Directive or Franchise agreements)			
We consider ethical and human rights/ welfare either formally or informally in our purchasing decisions			

Operational Processes	**Yes/ Do**	**No/ Don't**	**Intend to**	**N/A**
Paper recycling in offices is standard practice				
We recycle toner cartridges in the offices				
Energy efficiency measures are adopted for lighting and heating				
Computers are switched off when not in use or have screen savers				
We have implemented a combined heat and power system				
We are required by law to control the disposal of some of our wastes (e.g. medical waste)				
Waste generated through packaging is a significant cost to our organisation				
We have accredited to and Environmental Management Standard such as ISO14001 or EMAS				

Industrial Networks	**Yes/ Do**	**No/ Don't**	**Intend to**
The organisation is part of an <u>industry specific</u> or <u>govemmental</u> association that shares good practice / lobbying			
Is part of a 'green' network that shares environmental or ethical good practice or information			

Logistics	**Yes/ Do**	**No/ Don't**	**Intend to**	**N/A**
We consider environmental matters **generally** in our transport decisions				
We have invested in vehicles that are designed to have reduced environmental impacts				
We plan the routes of our vehicles in order to reduce environmental impacts				
We have energy efficiency systems in operation in our warehouses				
We ask suppliers to use recyclable pallet systems when they deliver supplies to us				
We expect our suppliers to take back their packaging or pallet systems they use to supply goods to us				

Supplier Assessment and Evaluation	**Yes/ Do**	**No/ Don't**	**Intend to**
We assess the environmental acceptability and performance of our suppliers **informally**			
We assess the environmental acceptability and performance of our suppliers in a **formal** process			
We **set environmental criteria** that suppliers **must meet**			
We have reduced our supplier base over the last 5 years and one of the criteria used to assess whether we kept that supplier was environmental criteria			

Supplier Education, Coaching and Mentoring	**Yes/ Do**	**No/ Don't**	**Intend to**
We communicate to our suppliers **our** environmental and/or ethical criteria for goods and services we buy			
We run workshops/seminars to share knowledge with our suppliers			
We educate our suppliers through written material			
We (or someone on our behalf) goes into our suppliers company to help them improve environmental performance			
We have received environmental guidance from our own customers			
We have been the recipient of educational workshops and visits by our customers to educate us on what environmental improvements can be made			

20. **Has your organisation ever been asked (or required) to make changes to its goods, services or operational practices by an EXTERNAL party for ENVIRONMENTAL reasons**

- ☐ No - Never been asked
- ☐ Yes
  - ☐ A firm we supplied to
  - ☐ Due to environmental legislation
  - ☐ An Overseas Parent company

Please give details if you wish ....

21. **To what extent does the consideration of environmental issues affect decisions made in purchasing and logistics?** *Please indicate which of the following statements is most appropriate*

- ☐ Environmental issues are considered above that of all other factors
- ☐ Environmental issues are given equal consideration with other factors
- ☐ Environmental issues are a secondary consideration after other more important factors, such as price.
- ☐ Environmental issues are not considered during purchasing or as part of logistics
- ☐ Environmental issues are not considered by the organisation at all.

22. **Do you ask suppliers about their environmental performance and standards?**

- ☐ No (go to Question 27)
- ☐ Yes (go to NEXT question)

23. **Are your environmental criteria common to all suppliers?**

- ☐ Yes – same criteria used for all suppliers
- ☐ No- different criteria used. Please explain why different environmental criteria or used or why some suppliers are not examined on environmental criteria

____

____

____

____

24. **Would you, or have you ever rejected a supplier who failed to meet environmental criteria.**

- ☐ Yes we have
- ☐ No we wouldn't
- ☐ Yes we would but have never had to

25. **Are you aware of situations where your environmental requirements or influence has subsequently led to that supplier setting environmental criteria for it's own suppliers?**

- ☐ No
- ☐ Yes ... please give details if you can

____

____

____

26. **How essential are the following environmental criteria or standards when assessing potential or current suppliers or products?**

Criteria	**Essential**	**Would like**	**Not Considered**
That the supplier meets the ethical/ fair trade standards we as a company use			
That the supplier meets the environmental criteria we as a company have designed			
That we have no adverse knowledge of, or see recent media coverage, of poor environmental/ethical performance of supplier			
That the supplier has an environmental policy			
That the supplier has accreditaed to an environmental management standard such as ISO14001 or EMAS			
That our suppliers have considered resource reduction, reuse and recycling in the design of products we use			
That our suppliers meet our environmental critria within a a set time period.			
Other Criteria: Please detail			

[N.B If you have any specific purchasing guidelines that discuss environmental and ethical criteria and would be prepared to show these to us please feel free to include a copy with the returned questionnaire. These will be held in strictest confidence.]

27. **Has your organisation ever been rejected as a supplier, by a customer (where the customer is another organisation) due primarily to environmental reasons?**

- ❑ Yes **This response will be confidential**
- ❑ No
- ❑ Do not wish to answer

28. **How much control does your organisation have over its decision making as regards environmental issues?** *Please select one statement that most closely describes the power relationship between you and your customers. [NB: Only those organisations that supply goods and services to OTHER organisations should answer this question]*

- ❑ It is our decision as to what environmental improvements we make and our customers have little influence over our decisions
- ❑ We have plenty of customers and if requested to make environmental improvements that we did not agree with, we would not do so, even if it meant losing that customer
- ❑ We would have no choice but to adopt whatever environmental criteria we are required to if our customers ask, irrespective of cost and inconvenience.
- ❑ We are more dependent on some customers than others. If asked to make environmental changes by our major customer(s) we would do so.

29. **How applicable are the following obstacles to <u>green supply chain management</u> in your organisation?** *Please circle one number in each row*

Not at all	To a small extent	To a moderate extent	To a great extent	To a very great extent
1	2	3	4	5

	Not at all – V. great extent
High costs of environmental compliance with legislation	1 2 3 4 5
Too expensive to initiate and run a green supply chain programme	1 2 3 4 5
Lack of managerial commitment to green supply chain management	1 2 3 4 5
Company wide indifference	1 2 3 4 5
Lack of trained personnel to implement such schemes	1 2 3 4 5
Poor quality of environmentally ‘friendly’ resources	1 2 3 4 5
Uncertainty of the availability of appropriate environmentally ‘friendly’ resources from suppliers	1 2 3 4 5
High cost of environmental purchasing programmes	1 2 3 4 5
Uneconomical to recycle packaging	1 2 3 4 5

Not economical to have products returned to us for reuse or remanufacture	1 2 3 4 5
Suppliers lack environmental awareness of our needs	1 2 3 4 5
Lack of company wide environmental management standards and auditing programmes in our supplier companies	1 2 3 4 5
Lack or vagueness of environmental legislation in packaging	1 2 3 4 5
Lack of internal guidance of green purchasing, greening logistics or supply chain as a whole	1 2 3 4 5
Lack or vagueness of environmental legislation in green purchasing and supply chain management	1 2 3 4 5
Lack of financial benefit/ profit from operating a green supply chain	1 2 3 4 5
Other please specify	
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

SECTION 6 RESPONDANT INFORMATION

30. **Are you involved in** *(tick all that apply)*

- ❑ purchasing
- ❑ logistics
- ❑ managerial decisions
- ❑ implementing environmental policies
- ❑ top management
- ❑ middle management
- ❑ an environmental division or have specific environmental responsibilities

Did any one else assist with the answers and if so please can you give details of what role they have in the organisation

____

____

____

____

____

____

____

FURTHER INFORMATION

To enable us to gain a more in-depth understanding we are keen to conduct a series of interviews with respondents. Please indicate if you would be willing to be approached by us during the next 12 - 18 months to participate in a more in-depth interview.

I am willing to be contacted to be interviewed further YES ☐ NO ☐

If you would like to make any additional commentary please feel free to do so below.

We would like to thank you again for your time and patience in completing this questionnaire, providing us with valuable input

APPENDIX 6: PILOT STUDY FEEDBACK SHEET

Greening the Supply Chain – Pilot Study Feedback

Thank you for agreeing to help us investigate Green Supply Chain Management by testing our research questionnaire. Your assistance will help us to ensure that we are asking the right questions when the questionnaire is distributed to over 1500 CIPS members.

Instructions:
Attached to this form you will find our questionnaire. Could you please complete the survey as fully as possible and then let us know answers to the following five questions

1. How long did it take you to complete this survey?

____

2. Were there any of the questions ambiguous or fail to make sense. *Please indicate which question number(s) this applies to*

____

____

____

3. In your opinion were any of the questions posed irrelevant *Please indicate which question number(s) this applies to*

____

____

____

4. In your opinion were there any obvious omissions from the questions posed? *Please indicate which question number(s) this applies to*

____

____

____

5. In your opinion were there any obvious duplicate questions posed? *Please indicate which question number(s) this applies to*

____

____

____

Thank you for your assistance. Please return completed questionnaire and feedback form in the SAE enclosed

APPENDIX 7: EDITS TO THE PILOT QUESTIONNAIRE IN ORDER TO DEVELOP THE FINAL VERSION OF QUESTIONNAIRE

Question	Edits	Purpose
1.	Main tick box categories removed and broader headings put in.	Too long and tedious. Information gathered from new classifications and q. 2 is sufficient
4	Overseas replaced with 'Global/overseas'	Suggestion of one of pilot respondents
7 & 8	Removed. Four respondents did not know or stated was confidential	Unlikely to get accurate response
19	Four respondents could not answer this question – replaced with ' Is your organisation critically dependent upon a small number of suppliers (i.e. could not continue with your operations without receiving their goods and services)	This question was mostly about dependency and channel power and is more understandable in this form
21	Respondents where overwhelmed by the length Some questions duplicated or too repetitive and some not answered-m these were merged or edited	Manufacturing only questions moved to separate section
22	Two respondents could not or would not respond. Mostly the responses were brief and only from the manufacturing section	Moved to manufacturing page and edited
24	Mistake made in routing of question	fixed
25	Moved to fit on page better Change headings and statements	Better structure Less ambiguous
31	Moved to manufacturing section	Better routing

APPENDIX 8: FINAL VERSION OF QUESTIONNAIRE

THE
CHARTERED INSTITUTE OF
PURCHASING & SUPPLY

MIDDLESEX UNIVERSITY
BUSINESS SCHOOL
LONDON

MANAGING ENVIRONMENTAL ISSUES THROUGH PURCHASING AND SUPPLY – A RESEARCH STUDY

by

The Chartered Institute of Purchasing and Supply

&

Centre for Interdisciplinary Strategic Management Research
Middlesex University Business School

All replies will be treated in the strictest confidence.

Thank you in advance for your co-operation and participation in this study. At the conclusion of the study we would like to send you an Executive Summary of the results. Please provide your name and address below. Otherwise please feel free to remain anonymous.

Name:
Position:
Company Name
Address:

Please return the questionnaire to us by <u>31st October 2002</u>

Please use the enclosed SAE to return your questionnaire to:
Chartered Institute of Purchasing and Supply,
Easton House, Easton on the Hill,
Stamford Lincolnshire PE9 3NZ

SECTION 1: COMPANY INFORMATION

1. **Please tick the box(es) that best describe your organisation's principal activity**

☐ Public	☐ Utility Company
☐ Voluntary/ Not for Profit Organisation	☐ Construction
☐ Service	☐ Manufacturing
☐ Mixed Service & manufacturing	☐ Transport & Logistics
☐ Retail/ Wholesale	☐ Agriculture

2. **Please describe briefly in words the nature of your organisation's activity (e.g. it's main business/ service activities)**

____

____

3. **Please describe the nature of your relationship with your market** *please tick one box*

☐ We supply goods or services to other organisations or businesses
☐ We supply goods or services to individual consumers (i.e. the general public)
☐ We supply goods and services to both individual consumers and to other businesses

4. **Which one of the following best describes your organisation?**

☐ New Venture ☐ UK independent ☐ UK Group ☐ Joint Venture

☐ Global/overseas Group -Please note the nationality of the parent company……………

5. **How many full time employees are there in your company/ site in the UK?**

☐ 1-9	☐ 100-250	☐ 1000+
☐ 10-49	☐ 250-499	If possible please indicate actual
☐ 50-99	☐ 500-999	number of employees ………………………

6. **Please tick the box that most appropriately represents the structure of your organisation and the role of the UK site within the broader organisational structure.**

☐ Main UK HQ with subsidiary sites controlled by HQ.
☐ Overseas HQ with subsidiary UK site(s) controlled by HQ
☐ Devolved UK site with independent authority to control purchasing and supply chain matters.
☐ Single UK site
☐ Franchise organisation.

7. **(a) What was the approximate total turnover of your organisation last year?**

____

(b) If your organisation is a subsidiary of an overseas organisation please indicate approximate turnover of the UK subsidiary last year

____

SECTION 2: OPERATING ENVIRONMENT AND ROLE OF ENVIRONMENTAL ISSUES

8. **(a) How important do you think the management of environmental issues, such as pollution, conservation, waste management, is to your organisation?** *Please tick one box*

☐ Extremely important ☐ Important ☐ Of moderate importance
☐ Of slight importance ☐ Not important at all

(b) How important do you think the management of ethical issues, such as fair trade and human rights is to your organisation? *Please tick one box*

☐ Extremely important ☐ Important ☐ Of moderate importance
☐ Of slight importance ☐ Not important at all

9. **Do you think that the importance of environmental issues to your company in the next five years will ....?** *(Please tick one box)*

☐ Increase ☐ Decrease ☐ Stay the same

10. **Please identify (via a tick in the appropriate column) the functions/departments that are primarily responsible for formulating environmental policy, implementation of environmental activities and monitoring and assessment of environmental actions.**

	Developing Environmental Policy	***Implementing Environmental Activities and Policy***	***Monitoring & Assessment of Environmental Activities***
Safety, Health and Environment			
Production and Operations			
PR and Marketing			
Engineering			
Facilities Management			
Legal Department			
Quality Unit			
Logistics and Transport			
Finance and Accounting			
Purchasing Department			
Executive Committee/ Board			
Other please name ________			
________			

SECTION 3: DRIVERS OF CHANGE AND STRATEGIC RESPONSE

11. **In your opinion what is the overall environmental risk posed by, and environmental impact of, your organisation?** *Please place one tick in each column*

Level	Possible Risk	Environmental Impact
Negligible		
Low		
Medium		
High		

12. **Which of the following statements most accurately describes your organisation's environmental policy?** *(Please tick one box)*

- ☐ We have a **formal environmental policy** and guidelines for dealing with environmental issues *(GO TO Q.13)*
- ☐ We have primarily an **informal or unwritten** environmental policy and guidelines **(GO TO Q14)**
- ☐ We have **no specific** environmental policy or guidelines **(GO TO Q14)**

13. **If you have a <u>formal written</u> environmental policy please indicate approximately how long you have had such a policy**

Less than 1 year ☐ 1-3 years ☐ 4-5 years 5 –10 years 10 years +

14. **Can you please rate the following factors in terms of their influence upon the way your organisation <u>manages environmental issues and addresses environmental issues?</u>** *(Please indicate the extent to which each factor has affected your organisation)*

Not at all	To a small extent	To a moderate extent	To a great extent	To a very great extent
1	2	3	4	5

		Not at all ....v. great extent
Legislation	UK's **current** environmental legislation	1 2 3 4 5
	EU's **current** environmental legislation	1 2 3 4 5
	Forthcoming environmental legislation	1 2 3 4 5
	Possible environmental legislation in the future	1 2 3 4 5
Supply Chain Factors	Requirements of organisations **that you supply to**	1 2 3 4 5
	Encouragement from organisations **that you supply goods and services to**	1 2 3 4 5
	Pressure from individual consumers/ service users	1 2 3 4 5
	Influence of your own suppliers that provide goods and services to **your organisation**	1 2 3 4 5

		Not at all ....v. great extent
Stakeholder / Societal Pressure	Public opinion/ societal expectation	1 2 3 4 5
	Pressure from green action groups (such as Greenpeace or Friends of the Earth)	1 2 3 4 5
	Maintaining or presenting an environmentally or socially responsible image	1 2 3 4 5
	Pressure from shareholders or investors (when applicable)	1 2 3 4 5
Internal Factors	Pressure from the Insurance Industry	1 2 3 4 5
	Pressure from employees	1 2 3 4 5
	The CEO (or equivalent) commitment to environmental improvement	1 2 3 4 5
	Culture of the organisation promotes environmental responsibility	1 2 3 4 5
Competitive Factors	Provides operational cost savings	1 2 3 4 5
	Provides new market opportunities	1 2 3 4 5
	To **match** the activities of competitors	1 2 3 4 5
	To **perform better** than our competitors or equivalent institutions	1 2 3 4 5
Risk	In order to reduce the health and safety risk associated with our goods, services or operational practices	1 2 3 4 5
	In order to reduce the public's perceived risk associated with our company	1 2 3 4 5
Other Factors?	*Please specify*	1 2 3 4 5
		1 2 3 4 5

SECTION 4: GENERAL PURCHASING AND LOGISTICS

15. **Approximately how many SUPPLIERS are providing goods and services to your organisation?** *Please tick the most appropriate box*

☐ 1	☐ 10-49	☐ 200-299	☐ 1000-2499
☐ 2-4	☐ 50-99	☐ 300-499	☐ 2500-4999
☐ 5-9	☐ 100-199	☐ 500-999	☐ over 5000

16. **Approximately how many CUSTOMERS (organisations or companies) do you provide goods or services to?** *Please tick the most appropriate box*

☐ 1	☐ 50-99	☐ 500–999	☐ Not Applicable – General Public
☐ 2-4	☐ 100-199	☐ 1000-2499	
☐ 5-9	☐ 200-299	☐ 2500-4999	
☐ 10-49	☐ 300-499	☐ over 5000	

17. **Is your organisation CRITICALLY dependent upon a small number of suppliers (i.e. could not continue with your operations without receiving their goods and services)**

☐ Yes – We have a few key suppliers whose goods and services are essential to our operations

☐ Yes – We have a few critical suppliers but there are other firms/organisations we can approach if the original suppliers were unable to supply us

☐ No – We have multiple sources of suppliers we can approach

18. ***Approximately* how much of your organisation's budget/ turnover is spent on <u>purchased goods/services</u>?** *please tick one box*

☐ Less than 10 ☐ 10-20 % ☐ 21-30% ☐ 31-40% ☐ 41-50%
☐ 51-60% ☐ 61-70 % ☐ 71-80% ☐ 81-100%

SECTION 5: OPERATIONAL PRACTICES

19. **Has your organisation ever been asked (or required) to make changes to its goods, services or operational practices by an EXTERNAL party for ENVIRONMENTAL reasons?**

☐ No - Never been asked
☐ Yes - please *give details below if you wish.*

20. **Which of the following actions does your organisation undertake?** *Please indicate level of response by your organisation by placing a tick in each relevant column*

- Yes/ Do at Present
- No/ Do not do or consider at present
- Intend to in next 12 months

Green Procurement and Logistics Policy	**Yes/ Do**	**No/ Don't**	**Intend to**
We have a **formal** policy on green procurement/ purchasing			
We have a **formal** policy on green logistics/transport			
We have a green purchasing or logistics **guidelines** that recommend the environment is considered			
We are bound by external purchasing directives (e.g. the EC Procurement Directive or Franchise agreements)			
We consider ethical and human rights/ welfare issues **informally** in our purchasing decisions			
We consider ethical and human rights/ welfare issues formally in our purchasing decisions			

Operational Processes	Yes/ Do	No/ Don't	Intend to	N/A
Paper recycling in offices is standard practice				
We recycle toner cartridges in the offices				
Energy efficiency measures are adopted for lighting and heating				
We actively manage the disposal of packaging wastes				
We actively manage the disposal of all solid wastes in the organisation				
We are required by law to control the disposal of some of our wastes (e.g. medical waste)				
We have accredited to an Environmental Management Standard such as ISO14001 or EMAS				

Logistics	Yes/ Do	No/ Don't	Intend to	N/A
We consider environmental matters **generally** in our transport decisions				
We have invested in vehicles that are designed to have reduced environmental impacts				
We plan the routes of our vehicles in order to reduce environmental impacts				
We have energy efficiency systems in operation in our warehouses				
We ask suppliers to use recyclable pallet systems when they deliver supplies to us				
We expect our suppliers to take back their packaging or pallet systems they use to supply goods to us				

Supplier Assessment and Evaluation	Yes/ Do	No/ Don't	Intend to
We assess the environmental acceptability and performance of our suppliers **informally in our assessment criteria**			
We assess the environmental acceptability and performance of our suppliers in a **formal** process			
We **set environmental criteria** that suppliers **must meet**			

Industrial Networks	Yes/ Do	No/ Don't	Intend to
The organisation is part of an **industry specific** partnership that shares good practice / lobbying			
The organisation is part of an group that sources products and suppliers (such as the Ethical Trading Initiative)			

	Yes/ Do	No/ Don't	Intend to
The organisation is part of a general 'green' network that shares environmental or ethical good practice or information			
The organisation is part of a supply chain initiative that is involved in active dialogue with suppliers and/or stakeholders			

Supplier Education, Coaching and Mentoring	Yes/ Do	No/ Don't	Intend to
We communicate to our suppliers **our** environmental and/or ethical criteria for goods and services we buy			
We run workshops/seminars to educate our suppliers			
We educate our suppliers through written material			
We (or someone on our behalf) goes into our suppliers' organisations to help them improve environmental performance			
We have received environmental guidance from our own customers			
We have been the recipient of educational workshops and visits by our customers to educate us on what environmental improvements can be made			

21. **To what extent does the consideration of environmental issues affect decisions made in purchasing and logistics?** *Please indicate which of the following statements is most appropriate*

- ☐ Environmental issues are considered above that of all other factors
- ☐ Environmental issues are given equal consideration with other factors
- ☐ Environmental issues are a secondary consideration after other more important factors, such as price.
- ☐ Environmental issues are not considered during purchasing or as part of logistics
- ☐ Environmental issues are not considered by the organisation at all.

22. **Do you ask suppliers about their environmental performance and standards?**
- ☐ No **(PLEASE GO TO QUESTION 27)**
- ☐ Yes **(PLEASE GO TO NEXT QUESTION)**

23. **Are your environmental criteria common to all suppliers?**
- ☐ Yes – same criteria used for all suppliers
- ☐ No- different criteria used. *Please explain why different environmental criteria or used or why some suppliers are not examined on environmental criteria*

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____

24. **Would you, or have you ever rejected a supplier who failed to meet YOUR environmental criteria.**
- ❑ Yes we have
- ❑ No we would not reject a supplier if they failed to meet environmental criteria we set
- ❑ Yes we would reject a supply if they failed to meet our environmental criteria

25. **Are you aware of situations where your environmental requirements or influence has subsequently led to that supplier setting environmental criteria for it's own suppliers?**
- ❑ No
- ❑ Yes ... please give details if you can

____

____

____

____

26. **How essential are the following environmental criteria or standards when assessing potential or current suppliers or products?**

Criteria	**Essential**	**Would like**	**Not Considered**
That the supplier meets the ethical/ fair trade standards we as a company use	π	π	π
That the supplier meets the environmental criteria we as a company have designed	π	π	π
That we have no adverse knowledge of, or see recent media coverage, of poor environmental/ethical performance of supplier	π	π	π
That the supplier has an environmental policy	π	π	π
That the supplier has accredited to an environmental management standard such as ISO14001 or EMAS	π	π	π
That our suppliers have considered resource reduction, reuse and recycling in the design of products we use	π	π	π
That our suppliers meet our environmental criteria within a set time period.	π	π	π
Other Criteria: Please detail below	π	π	π
	π	π	π
	π	π	π

[N.B If you have any specific purchasing guidelines that discuss environmental and ethical criteria and would be prepared to show these to us please feel free to include a copy with the returned questionnaire. These will be held in strictest confidence.]

27. **How much control does your organisation have over its decision making as regards environmental issues?** *Please select one statement that most closely describes the power relationship between you and your customers*

- ❑ It is our decision as to what environmental improvements we make and our customers have little influence over our decisions
- ❑ We have plenty of customers and if requested to make environmental improvements that we did not agree with, we would not do so, even if it meant losing that customer
- ❑ We have no choice but to adopt whatever environmental criteria we are required to if our customers ask, irrespective of cost and inconvenience.
- ❑ We are more dependent on some customers than others. If asked to make environmental changes by our major customer(s) we would do so.

28. **Has your organisation ever been rejected as a supplier, by a customer (where the customer is another organisation) due primarily to environmental reasons?**

- ❑ Yes **This response will be confidential**
- ❑ No
- ❑ Do not wish to answer

29. **How applicable are the following OBSTACLES to <u>green supply chain management</u> in your organisation?** *Please circle one number in each row*

Not at all	To a small extent	To a moderate extent	To a great extent	To a very great extent
1	2	3	4	5

	Not an obstacle – V. great extent
Lack of financial benefit/ profit from operating a green supply chain	1 2 3 4 5
Lack of managerial commitment to green supply chain management	1 2 3 4 5
Suppliers lack environmental awareness of our needs	1 2 3 4 5
Company wide indifference	1 2 3 4 5
Lack of trained personnel to implement such schemes	1 2 3 4 5
Uncertainty of the availability of appropriate environmentally 'friendly' resources from suppliers	1 2 3 4 5
Difficulty in assessing supplier's environmental and ethical performance in an efficient and cost effective manner	1 2 3 4 5
Other please specify	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

SECTION 6: MANUFACTURING, LOGISTICS OR SUPPLY ORGANISATIONS ONLY
TO BE COMPLETED ONLY BY FIRMS THAT MAUFACTURE PRODUCTS OR SUPPLY PRODUCTS TO OTHER ORGANISATIONS. **(All other respondents please go to SECTION 7)**

30. **Please indicate whether your organisation does any of the following**

	Yes/ Do	No/ Don't	Intend to	N/A
Our original packaging or pallet systems are returned to us from our customers				
At least one Life Cycle assessment has been undertaken to reduce the environmental burden of our products				
Components or materials used in making our products have been substituted for more environmentally friendly alternatives				
Our products have been designed for dis-assembly				
We have had to make changes in our products due to environmental legislation				
We recover products and/or components from customers for overhaul and remanufacture				
We use backloads on transports to return materials to us				
We will not take back our packaging/ pallets				
We will not take back goods (unless faulty)				
We are affected by EC Directives on end of life products (such as new Electronics Directive)				
We are required to address the recycling of our packaging under the Packaging Directive				
During new product development we involve **potential suppliers** in the design stage of the process				
During new product development we involve **customers** in the design stage of the process				
We undertake some form of environment life cycle assessment during the design stage of new products				
We source at least some of our components so that they come from environmentally or ethically sound sources				

SECTION 7: FURTHER INFORMATION

31. **Which of the following are you involved in** *(tick all that apply)*

- ☐ purchasing
- ☐ logistics
- ☐ managerial decisions
- ☐ top management
- ☐ middle management
- ☐ implementing environmental policies
- ☐ an environmental division or have specific environmental responsibilities

Please indicate if you would be willing to be approached by us during the next 12 - 18 months to participate in a more in-depth interview.

I am willing to be contacted ☐YES ☐NO

Additional Comments

WE WOULD LIKE TO THANK YOU AGAIN FOR YOUR TIME AND PATIENCE IN COMPLETING THIS QUESTIONNAIRE

APPENDIX 9: QUANTITATIVE DATA ANALYSIS

This appendix provides an overview of the statistical analysis of the data used in this thesis , as discussed in section 5.5.

Descriptive Information

A descriptive overview of data involves the production of summary information on measurements of central tendency and distributions from interval/ratio and ordinal data. This type of analysis includes identifying means (average value when summed and divided by total number of values), medians (mid point of a distribution) and mode (most frequent value). Measurements of distribution also involve identifying the range (highest and lowest) and interquartile ranges (which take 25th and 75th value) which eliminate extreme values. The standard deviation is the most common form of summarising dispersion and calculates the amount of deviation from the mean value. Another method for assessing dispersion (linked to the standard deviation) is whether the distribution is normally distributed, and is an important consideration when deciding between parametric or non-parametric statistical tests. Nominal data can be described using tables of frequency that identify total amounts and percentage distributions of the findings.

Parametric versus Non Parametric

The debate surrounding the choice between parametric and non-parametric tests is examined by Bryman and Cramer (2001) who note that many argue that parametric tests should only be used when the:

- Level or scale of measurement is interval or ratio based, not just ordinal;
- Distribution of the population is normally distributed; and
- Variances of both variables are equal or homogeneous.

The term parametric describes a measure of distribution such as the mean or the variance and is dependent on the assumptions detailed above. Non-parametric tests do not make the above assumptions about the precise form of the distribution.

Lord (1953) suggests that parametric tests can be applied to ordinal data since the tests apply to numbers and not what the numbers represent and tests are treated as if the data is interval based. Bryman and Cramer (2001:115) note that parametric tests are routinely applied to ordinal data in psychological and sociological studies. Parametric tests are also used on ordinal data in the prior research in green supply chain management studies identified in chapter 1. Bryman and Cramer (2001) also note the work by Boneau (1960) and Games and Lucas (1966) where statistical analysis of data set up to violate normality assumptions was found to produce similar results irrespective of whether parametric or non-parametric tests were used. However, it is prudent to run both parametric and non-parametric analyses when the conditions for parametric tests are not met (Bryman and Cramer 2002:117).

De Vaus (2002) also explores the issue of using parametric tests for non-normally distributed data and states:

> '*Statistical experimentation has demonstrated that violating the normality assumptions of tests has less severe effects than previously thought. Although there is little theoretical justification for ignoring the normality assumptions, in practice it does not seem to have a severe effect upon results* (de Vaus 2002: 78).'
> '*For larger samples (100+) you can safely use parametric statistics*' (de Vaus 2002: 295).

Since there are 149 respondents to the survey questionnaire it could be argued that this condition outlined by de Vaus has been met, suggesting that parametric testing might be used. However, in order to be cautious non-parametric tests such as Kruskal Wallis, are mostly used when normality assumptions are not met.

Significance Tests of Differences between Groups

Table 9.1 illustrates the types of tests that are available to identify significant differences between groups. For example the Kruskal-Wallis test is widely used in the analysis of the data in this study, examples include identifying if environmental behaviour varies between different sectors, or sizes of organisations. A significant difference might suggest that the dependent variable (such as environmental behaviour) is affected by the independent variable (such as sector, size).

T Tests

This is a parametric test used for testing the null hypothesis that two populations' means are equal (if population is normally distributed and variances are equal). In this tests both equal and unequal variance can be examined using Levene's test. If the probability adjacent to the value of F is greater than the significance level, which is normally 0.05, then assessment of significance based on Levene's test of equal variances applies.

Table 9.1: Tests of difference (Bryman and Cramer 2001)

Nature of Criterion variable	Type of Test	Type of data	No. of comparison groups.	Name of test
Categorical: Nominal or Frequency	Non-parametric	Unrelated	1	Binomial
			1	Chi-squared
			2+	Chi-squared
		Related	2	McNemar
			3+	Cochran Q
Non-categorical	Non-parametric	Unrelated	1-2	Kolmogorov-Smirnov
			2	Mann-Whitney U
			2+	Median
			3+	Kruskal-Wallis H
		Related	2	Sign
			2	Wilcoxon
			3+	Friedman
	Parametric: Means	Unrelated	1-2	T Test
			2+	One way or two way ANOVA
		Related	2	T Test
			2+	Single factor repeated measures
		Related & unrelated	2+	Two way ANOVA with repeated measures of one factor
	Parametric: Variances	Unrelated	2+	Levene's test
		Related	2	T Test

Some of the tests of difference identified in this table are explored in the following section.

Mann-Whitney U Test

Puri (2002) identifies the Mann-Whitney U Test as an alternative test for T Tests when the data used is not parametric (i.e. the sample does not show a normal distribution), and actual data values are replaced by ranks for calculation. It tests a null hyphotheis (H_0) that there is no difference between the means of two samples. The null hypothesis is rejected if $p< 0.05$.

Analysis of Variance (ANOVA)

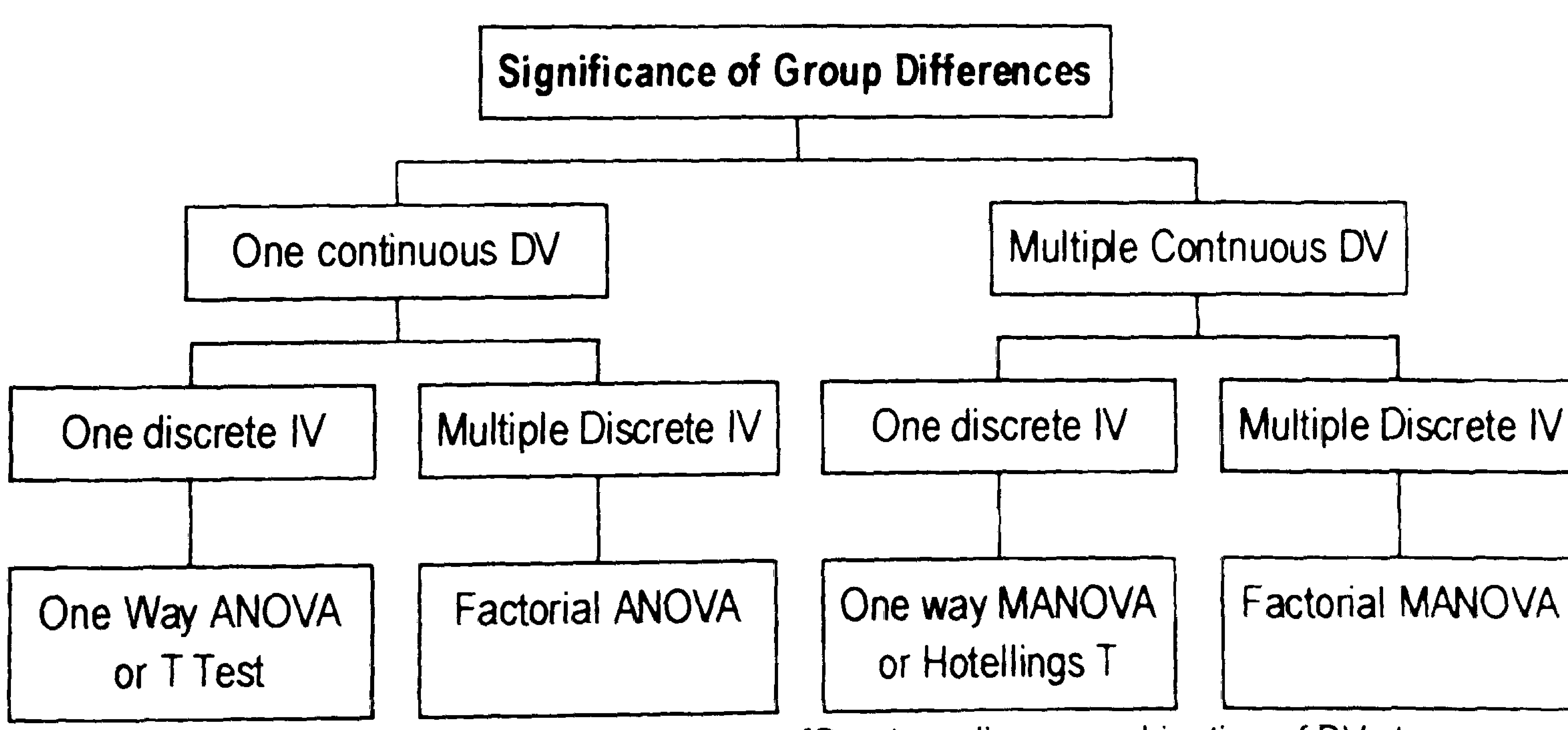
Analysis of variance (ANOVA) is a method of testing the null hypothesis that several group means are equal in the population, by comparing the simple variance estimated from the group means to that estimated within the groups (summarized in figure 9.1)

One way ANOVA. This is a generalisation of an independent t-test. Assumptions made are detailed by Puri (2002) as;

- data measured on a ratio or interval scale;
- each group is an independent random sample;
- each group comes from a normally distributed population; and
- population variances are equal (which can be tested using Levene test of equality of variance) [1].

Simple Factorial ANOVA. This can handle several grouping variables (factors) simultaneously. Otherwise the assumptions are as detailed for the one–way ANOVA.

General Factorial ANOVA. In this technique a covariate is a variable that is measured in addition to the dependent variable in ANOVA and represents an additional, uncontrolled for, source of variation in the dependent variable. The covariates are added to the univariate box in SPSS. The non-parametric alternative to ANOVA is the Kruskal Wallis test. However this test does not identify which group is significantly different from the others, only that one or more group is. The researcher can then examine the mean rank score to see in what rank order the groups appear and what the differences are between each group.



[Determines the reliability of mean group differences]

[Creates a linear combination of DVs to maximise mean group differences]

IV – independent Variables DV – Dependent Variables

Figure 9.1: Summary decision tree – significance of group differences for parametric data (adapted from Tabachnick and Fidell 1996)

[1] Puri (2002) notes that one way ANOVA is fairly robust to small deviations in equality of variance

Examining differences between categorical variables

Cross-tabulations are one of the simplest and most frequently used ways of demonstrating the presence of significant differences between groups, using the comparison of independent unrelated categorical data in the form of contingency tables. The general conditions for using the tests identified in this section are described by Puri (2002) and detailed below:

- The data is categorical (nominal qualitative or ordinal in ordered categories);
- The actual values of the data, their frequencies should be used in contingency tables (with proportions and percentages not used);
- The variables should be unrelated and independent; and
- Tests are non-parametric and so the parent population needs to have no specific distribution.

The chi-squared tests is used in cross tabulations to compare the observed frequencies of cases with those expected to establish if there are statistically significant differences between groups. Expected frequencies are assumed to be equal and the hypothesis is tested that each category will contain the same number of cases. Bryman and Cramer (2001) as detailed below identify the restrictions on using chi-squared.

- When there are only two categories the number of cases expected to fall in each category should be at least five, before chi-square test can be used.
- When there are three or more categories chi-square should not be used when the expected frequency is smaller than one (or when more than 20% of expected frequencies are smaller than five).

Exploring Relationships

A relationship between two variables exists when the variation exhibited by one variable is associated with the distribution exhibited by another variable and is examined using some form of correlation/regression or chi-squared test. There are five types of statistical techniques that can be used to examine the degree of relationship between variables: bivariate r, multiple R, sequential R, canonical R and multiway frequency analysis (adapted from Tabachnick and Fidell 1996). The next section now briefly examines some of these techniques (summarised in figure 9.2).

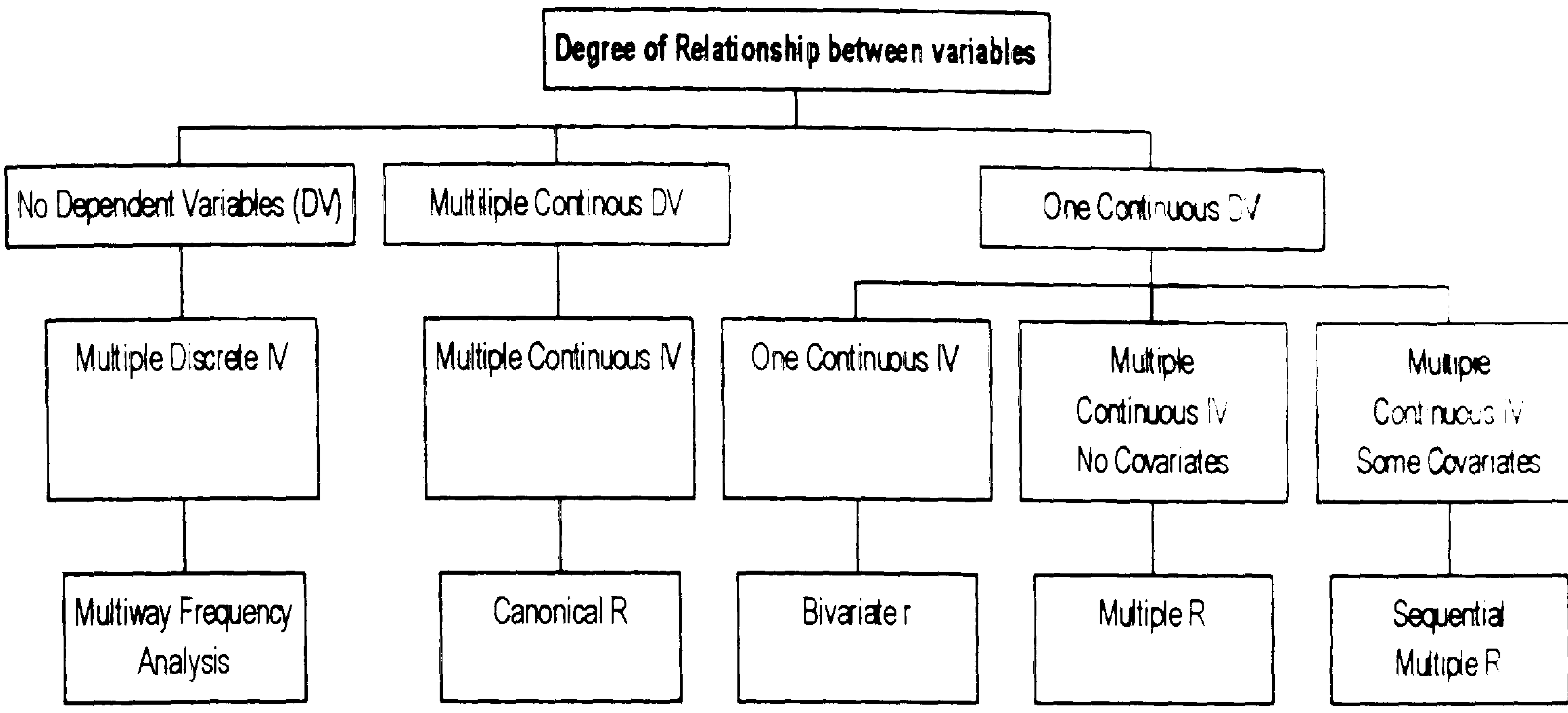


Figure 9.2: Decision tree for identifying correlation and regression techniques (adapted from Tabachnick and Fidell 1996)

Bivariate r

Tabachnick and Fidell (1996:53) state that '*powerful research sometimes produces results that are statistically significant but realistically meaningless*'. Strength of association assesses the proportion of variance in a dependent variable according to different levels of an independent variable. Assessing the total variance in a dependent variable is predictable from knowing the levels of an independent variable. Thus, statistical significance testing assesses the reliability of an association between an independent and dependent variable and strength of association testing measures how much association there is. Correlations are used to measure the association between variables, with the squared correlation value measuring this strength of association. Whereas regressions predict one variable using another. Bivariate correlations and regressions use two continuous variables

Correlations indicate both the strength and the direction of a relationship between two variables. Interval or ratio data that satisfies the normality assumptions can be tested using the Pearson product moment correlation (r). If scatter diagrams indicate the relationship is not linear then researchers often use a logarithmic transformation of the independent variable. If the data is not normally distributed then the non-parametric tests of Spearman's rank correlation or Kendell's tau-b test can be used.

The Pearson Product Moment Correlation Co-efficient measures the strength of the relationship for bivariate data. If two variables are positively correlated then they tend to increase together and if they are negatively correlated one decreases as the other variable increases. The value of this coefficient ranges from –1 to 1. A value of 1 represented a perfect positive correlation and a value of zero represents no correlation. A value of minus one (-1) represents a perfect negative correlation.

In order to use Pearson's r variables must be interval and the relationship linear. If variables are ordinal Spearman's rho or Kendall's tau can be used as alternatives. One of the main reasons for the widespread use in the social sciences of questionnaire items built into scales and indices (which are then treated as interval variables) is the preference by researchers to use the Pearson's r test (Bryman and Cramer 2001). The regression technique shares many of the assumptions common with Pearson's r correlation coefficient. The linear regression line equation can be used to predict values of y for given values of x.

Partial Correlations

This technique assess the influence of a third variable upon a bivariate correlation and is used to identify if there is a spurious, indirect or direct affect of variable Z upon the relationship between X and Y (see De Vaus 2002 for a detailed examination).
Using Pearson r correlation coefficients in SPSS both zero order and partial correlations are examined to see how the third variable influences the relationship. These two sets of correlations are examined according to the protocol below

Table 9.2: Interpretation of partial correlations

Size of Correlation	Statistical Significance	Confidence Intervals	Interpretation
Similar	Both significant	Overlap	Replication Z has no impact on X and Y
Partial lower than zero	Zero order – significant Partial – non-significant	Do not overlap	Completely spurious, indirect or combination
Partial lower than zero order	Both significant	Do not overlap	Partly spurious, partly indirect. but still some direct relationship remains

Source: De Vaus 2002: 340

Multiple and Sequential Regression

When there are more than two continuous variables then we can use multiple correlation (one continuous dependent variable related to a composite variable comprising of a range of independent variables), or multiple regression (used to predict the score of a dependent variable based on scores on several independent variables). The conditions for a multiple regression are that the dependent variable is interval and the independent variables are interval (or dichotomous).

The practical issues associate with regression are explored by Tabachnick and Fidell (1996) and examined briefly below. These issues also apply to bivariate regression examined in the previous section.

Number of Cases needed for Regression

The number of cases available is an important consideration in regression.

- Testing multiple correlations: $N > 50 + 8m$ where m is the number of independent variables
- Testing individual predictors: $N > 104 + m$

Therefore when there are six predictors there needs to be a minimum of 98 cases to test regression and 110 cases for testing individual predictors (Green 1991, cited in Tabachnick and Fidell 1996:132). Based on the 149 cases in this thesis the maximum number of predictor variables that can be used in the above scenario is 12.

However if the dependent variable is not normally distributed, or errors in measurement are expected, then more cases are needed. Green (1991) suggests the following formula in these cases:

$$N > (8/f^2) + (m-1)$$

Where $f^2 = 0.01$ (small effect size), 0.15 (medium effect), 0.35 (large effect)

More cases are needed to establish small effects. When large effects are being investigating then:

$$N \geq (8/(0.35*0.35)) + (m-1)$$

i.e. Number cases $\geq 64 +$ number of independent variables

Stepwise multiple regression requires even more cases, normally at least 40 cases per independent variable (Tabachnick and Fidell 1996).

Outliers

Extreme cases can have a large impact on regression equations and can be deleted or transformed. Tabachnick and Fidell (1996) suggest that researchers should screen for outliers before running a regression as part of a descriptive evaluation of data.

Multicollinearity and Singularity

This occurs when independent variables are highly inter-correlated. Multicollinearity is identified when $r > 0.9$ and singularity refers to the redundancy of a variable because it is a combination or two or more others.

Normality, Linearity, Homoscedasticity and Independence of Residuals

This can all be examined using residual scatterplots between predicted dependent varaible scores and errors of prediction. Typically lack of normality and non-linearity of residuals is addressed by transforming variables. Homoscedasticity can also be reduced by transforming variables or by the interaction of an independent variable with another variable not in the original regression, or by using weighted (generalised) least squares regression.

In a standard multiple regression the independent variables are all added to the regression model without any preference. However in Sequential Regression, sometime known as hierarchical regression, the continuous independent variables are entered into the multiple regression in an order specified by the researcher. Another sequential form of multiple regression is statistical stepwise or setwise regression. In these types of regression the order of entry of the independent variables is determined by statistical formulas. Stepwise regression is considered the way to produce the best predictive equation (Tabachnick and Fidell 1996).

Summary of 'Rules of Thumb' for different combinations of variables.

Bryman and Cramer (2001) summarise a series of 'rules of thumb' for assessing different combinations of variables as illustrated below.

(1) Nominal and Nominal – Contingency Tables in conjunction with Chi squared

(2) Ordinal and Ordinal – Spearman's rho or Kendall' tau

(3) Interval and Interval – Pearson's r and regression

(4) Dichotomous and Dichotomous- Contingency Tables in conjunction with Chi squared but uses phi instead of Cramer's V

(5) Interval and Ordinal – If the ordinal variable has a large number of categories then it is best to use rho or tau. Contingency tables can be used when smaller number of variables. If the interval variable is able to identified as the independent variable can use means procedure to calculate an F ratio

(6) Interval and Nominal or Interval and Dichotomous – Contingency tables plus use of Chi squared if interval can be collapsed into categories

(7) Nominal and Ordinal – Contingency Tables in conjunction with Chi squared.

Latent Constructs, Data Reduction and Identifying Dimensions of a Concept

One of the main statistical focuses in advanced empirical research is the search for latent structure(s) underlying a set of variables. Depending on whether the search for structure is empirical or theoretical the choice is Principal Components Analysis (PCA), Factor Analysis (FA) or Structural Equation Modelling (de Vaus 2002; Tabachnick and Fidell 1996). This next section examines the use of factor analysis for reducing large datasets to numerical scale variables, and identifying if a series of constructs can be reduce to a number of dimensions.

Factor Analysis and Principal Components Analysis

Principal components analysis (PCA) and Factor Analysis (FA) are data reduction techniques that attempt to produce a smaller number of linear combinations of original variables in a way that accounts for most of the variability in the correlations between variables. As de Vaus (2002) and Pallant (2002) note the phrase 'factor analysis' is often used as a term to describe both exploratory factor analysis and principal components analysis (PCA). PCA is not a form of factor analysis, rather a components analysis. Many of the research studies that identify factor analysis as the data reduction technique can actually be referring to principal components analysis (de Vaus 2002: Munro and Page 1986; Pallant 2002).

In PCA all the original variables are transformed to a smaller number of linear combinations that captures most of the variability in the pattern of correlations. Whilst FA uses a mathematical model where only shared variance is analysed (Pallant 2002:151). PCA tends to be used when looking for the empirical structure of a dataset and FA, when the search is for a theoretical structure. The aims of factor analysis are identified by Evans (2001)[2] as:

- the interpretation of factors as amalgamations or simplifications of original variables;
- measuring the relative importance of several factors;
- comparing groups to see if they share a similar factor structure;
- estimating factor scores for each individual in the sample; and
- testing the factor structure to see of if supports other samples supposed to be from the same population – referred to as confirmatory factor analysis

De Vaus (2002) and Pallant (2002) suggest that during data preparation both FA and PCA's are examined. De Vaus (2002:143) suggests that in a practical sense there are few differences between a PCA and FA[3]. Tabachnick and Fidell (1996:664) suggest that PCA should be used when the aim of the data reduction process is to demonstrate an empirical summary of the data set, on the other hand FA should be used when inferred, hypothetical factor solutions are required. Stevens (1996:363) suggests that PCAs are psychometrically sound, similar mathematically and avoids the problems factor indeterminacy associated with factor analysis.

This study uses PCA to aid in the development of new scale variables to measure the drivers of environmental management and the possible obstacles to green supply but the

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[2] Evans (2001) Multivariate Statistical Methods Factor Analysis (1) Middlesex University
[3] For example a PCA and FA (principal axis factoring) on the items measuring the legislative drivers in chapter 7 produce scale variables which, when correlated produce a Pearson Correlation of 0.987 at p= 0.000, explaining 97.3% of variance. This confirms that these scales are virtually identical.

comments made by authors such as Bryman and Cramer (2001), De Vaus (2002) and Pallant (2002) are equally valid for both factor analysis and PCA. Bryman and Cramer (2001) identify *exploratory factor analysis* as a method to identify relationships between variables, without determining the extent to which the results found fit a particular model, whereas *confirmatory factor analysis* compares the solutions found against specific hypotheses.

Exploratory Factor Analysis/PCA

The first step in a PCA/exploratory factor analysis is to develop a correlation matrix between the items that make up the scales under investigation. If there are no significant correlations then this means the scales are unrelated and we would not expect them to form one or more factors. The relationship between each variable is classed as a 'loading'. There should ideally be 100+ individual cases per analysis (Gorsuch 1983).

Pallant (2002) and De Vaus (2002) examine the preliminary steps that should be undertaken in assessing the suitability of data for factor analysis[4].

1. *Examine the correlation matrix*. Items that demonstrate a correlation of greater than 0.3 are suitable for factor analysis (after Tabachnick and Fidell 1996)
2. *Bartlett's test of Sphericity (Bartlett, 1954).* Pallant (2002) suggests that this test should be significant at $p<0.05$ for factor analysis to be appropriate.
3. *Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser 1970:1974).* Tabachnick and Fidell (1996) suggest that a minimum value of 0.6 is required for a good factor analysis.
4. *Examine the internal reliability of the data*. The most common way of measuring the internal consistency of data (the degree to which items that make up a scale are all measuring the same underlying attribute), is Cronbach's coefficient alpha. Nunnally (1978) and de Vaus (2002) suggest that a minimum level of 0.7 is normally considered to indicate a reliable set of items.
5. *Examine communality*. De Vaus (2002) notes that communalities explain the amount of variance in a variable that is explained by the extracted factors. The higher the value is on a scale of 0-1 then the better the fit of that variable in the analysis and items with

[4] The use of the phrase 'factor analysis' incorporates principal component analysis.

low communalities should be dropped.

6. *Select number of factors.* The most common method of controlling the number of factors to be extracted is to extract only the components that have an eigenvalue greater than 1.
7. *Examine the scree plot (Catell 1966).* In this test the eigenvalues of the factors are plotted and the plot inspected to find a point at which the shape of the curve changes direction and becomes horizontal Catell recommends retaining all factors above the break in the plot as these factors contribute the most to the examination of the variance in the data set (Pallant 2002).
8. *Factor Rotation and Interpretation.* In order to interpret the factors that have been produced in SPSS the factors are rotated using a variety of methods. The two forms of rotation are orthogonal (where the assumption is that the factors are not correlated) or oblique (where the assumption is that factors are correlated). Tabachnick and Fidell (1996:666) suggest that in practice these two approaches often result in similar solutions. The most common oblique rotation is Direct Oblimin and the most common orthogonal rotation is Varimax. Tabachnick and Fidell (1996) suggest that orthogonal rotation will result in a solution that is easier to interpret and report.

Choosing an extraction method and rotation technique

Tabachnick and Fidell (1996) present a comprehensive evaluation of all the different type of factor analysis (including PCA) and rotational techniques that are available in most statistical packages. However, even though there are a large number of possible combinations between extraction and rotation, in practise the differences in results between them are often slight (Fava and Velicer 1992; Velicer and Jackson 1990). Most researchers begin data reduction and interpretation by undertaking a PCA with varimax rotation. From these results the factorability of the correlation matrix, rank of the observed correlation matrix, number of factors and variables that can be excluded from subsequent analysis, are examined (Tabachnick and Fidell 1996). Then researchers then repeat the factor analysis using appropriate combinations of extraction techniques and rotation until the best solution is found.

O'Toole and Donaldson (2002) recommend that oblique rotation should be used in most behavioural research in the anticipation that factors are highly intercorrelated. Whereas

Tabachnick and Fidell 2001) suggest that Varimax orthogonal rotation is the most commonly used default option. Only one group of constructs (the obstacles to green supply) extract two+ factors and thus required rotation (section 8.**). Both of these two components (supplier and internal) were rotated firstly by varimax and separately by direct oblim. Both sets of new variables were correlated and produced pearson's r = 0.980 (internal obstacles) and r = 0.977 (supplier obstacles). These findings suggest that there was very little difference between the two rotation methods, confirming the comments of Fava and Velicier (1992) and Velicer and Jackson 1990.

Use of Data Reduction Techniques in this Study

The data collected from the survey used in this thesis to test the pressure/response model of green supply chain management uses a large number of items to measure a range of concepts. This data needs to be converted to continuous scale variables for use in correlations and multiple regressions. New variables are developed later in this thesis to measure the external and internal drivers of environmental management and the obstacles to green supply chain management.

The first stage of the data reduction process used in this thesis involves an exploratory factor analysis. The data reduction technique of PCA is used to provide an empirical summary of the dataset (after Tabachnick and Fidell 1996:664). However, as noted earlier in this chapter both a PCA and FA should be undertaken (De Vaus 2002; Pallant 2002) to check that different solutions are not identified. Both PCA and FA are used at this exploratory stage and similar solutions found (for a correlation between the PCA scale and FA scale (principal axis factoring) measuring the legislative drivers is positively correlated at r = 0.987 suggesting the scales are identical). The PCA analysis identifies how many dimensions are measured by each cluster of items in the questionnaire. In the case of the 'driver' scales each the items measuring societal, legislative, supply chain, competitive and internal drivers all load on one factor each, therefore requiring no rotation. The items measuring the obstacles to green supply load on two factors, identified as internal and supplier obstacles[5], rotated using varimax rotation.

[5] Detailed in full in chapter 7 (external drivers) and chapter 8 (internal drivers and obstacles)

Once the number of dimensions for each concept is identified the data is also transformed using 'average scores'. This consists of summing the total score for each cluster of items and then dividing by the total number of responses. The use of average means is more advantageous than the PCA values as the mean score can be related to the original likert scale used in the questionnaire.

For example, the legislative drivers are measured using four items in the original questionnaire. The PCA identifies that there is only one factor and that all four items measure one concept. The likert score of 1 (negligible) to 5 (very great extent) for all four items are totalled and then divided by the total number of responses. If only 3 of the items are answered then only 3 values are used to develop the average mean. To test that this is a valid technique the PCA scale and the average mean scale are correlated. In the case of the legislative driver scales a correlation between the PCA and the average mean scale for the legislative drivers produces an r value of 0.985. This suggests that the PCA and average mean scales for the legislative drivers are virtually identical and that either can be used.

APPENDIX 10: ADDITIONAL COMMENTS ADDED TO THE FINAL QUESTIONNAIRE IN THE OPEN ENDED SECTIONS

Additional Drivers of Change

Case 9 – Governmental Agenda recorded as driver of change (to very great extent 5)

Case 13 – Political embarrassment considering our role as an organisation (that of body associated with nature protection) – influence as driver of change great extent (4)

Case 56- stakeholders (DTI) to a moderate extent (3)

Case101 – reputation as lead environmental body in UK (v great extent 5)

Case 127 – marketing awareness (v gt extent 5)

Case 128 – pressure from environmental agency (v gt extent 5)

Case 131 – Hierarchy of moral legal commercial obligation (v great extent 5)

To be highly respected (v gt extent 5)

Additional Obstacles

Case 55 – obstacles to green supply chain management time and resources required to action an environmental policy (great extent 4)

Case 70 – EC directives (great extent 4)

Case 101 – resource pressure on procurement (moderate extent 3)

Case 104 Resources to manage supply chain (5)

Devolved procurement environment (5)

The nature of our business (5)

Q26 environmental criteria and standards

Case 101 - Has a senior manager responsible (essential)

Has identified main environmental impacts (essential)

Case 108 – has not been prosecuted for environmental offence (would like)

Further Comments

Case 55

As a management consultant I have been involved in the creation and implementation of environmental policies at my client organisation. The effort and resources needed are considerable and this is the major obstacle to developing an environmental policy. Once this policy has been established and a full training programme completed the next stage of completing the aspects and impacts assessment is no small task. This too requires effort and resources. The greatest motivator for an organisation to create and implement and environmental policy us the need to publish the corporate social responsibility report with the company annual report for the AGM. The chairman is the main driver of this

Case 63

The are many missed opportunities for recycling equipment paper furniture etc. We recycle toner cartridges but this seems to be a push from the buyer – she uses the money for charity rather than company policy

Case 81

Some of my answers would not be so cut and dried as the suggested responses but I think it's admirable that as an organisation we have taken this step to move those issues up the current agenda.

Case 93

It is our findings that environmental issues are very costly to our organisation for which there is no assistance

Case 97

I work for a district council and a lot of these questions do not apply

Case 100

Questionnaire was very length and covered a wide range of departments and functions within the organisation. I did not always have the specific knowledge of each department required to complete the questionnaire

Case 101 – As the environment agency you would expect us to be proactive. We have undertaken a great deal of R&D benchmarking our environmental performance and produce an annual report each year. //www.environment-agency.gov.uk/business/317943

Case 104

Questionnaire substantially biased towards manufacturing and private sector, which made elements/some questions hard to respond to. Public sector organisations especially universities have many diverse but (in value/£ terms) relatively insignificant supply chains. This means we have numerous 'virtual small businesses' and this makes implementing any procurement policy (let alone environmental where there is potentially a cost and limited, if any benefit to the individual department or researcher) difficult/challenging

Case 119

I reply on behalf of the organisation. Feel personally environmentally aware but I would not be allowed to base decisions on environmental evidence as opposed to financial. This creates conflict between work and my personal beliefs. The organisation always tends to have a delayed response to modern business practices, some of which are even rejected, at the most senior level. As far as I know environmental criteria are not even recognised at the most senior level and it may take legislative pressure to change this.

Case 122 Approach would be more beneficial at national level purchasing and supply agency/ NHS

Case 132 We care very much about the environment we live and work in. We make every effort to recycle as much as we can and take into account when making decisions what effects they have globally. We also purchase from 1/10/02 20% of our energy as green

Case 133 company just acquired

APPENDIX 11: WORKED EXAMPLE OF DATA TRANSFORMATION AND USE OF KRUSKAL WALLIS TESTS OF DIFFERENCE

STAGE 1: DATA REDUCTION USING PCA

Correlation Matrix

		influence of UK's current environmental legislation	EU's current environmental legislation	Forthcoming environmental legislation	Possible environmental legislation in the future
Correlation	influence of UK's current environmental legislation	1.000	.764	.623	.512
	EU's current environmental legislation	.764	1.000	.665	.512
	Forthcoming environmental legislation	.623	.665	1.000	.827
	Possible environmental legislation in the future	.512	.512	.827	1.000
Sig. (1-tailed)	influence of UK's current environmental legislation		.000	.000	.000
	EU's current environmental legislation	.000		.000	.000
	Forthcoming environmental legislation	.000	.000		.000
	Possible environmental legislation in the future	.000	.000	.000	

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.714
Bartlett's Test of Sphericity	Approx. Chi-Square	375.009
	df	6
	Sig.	.000

Communalities

	Initial	Extraction
influence of UK's current environmental legislation	1.000	.708
EU's current environmental legislation	1.000	.732
Forthcoming environmental legislation	1.000	.828
Possible environmental legislation in the future	1.000	.688

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.955	73.883	73.883	2.955	73.883	73.883
2	.657	16.432	90.315			
3	.242	6.038	96.353			
4	.146	3.647	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

Component Matrix[a]

	Component
	1
influence of UK's current environmental legislation	.841
EU's current environmental legislation	.856
Forthcoming environmental legislation	.910
Possible environmental legislation in the future	.829

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

STAGE 2: DEVELOPMENT OF AVERAGE SCORES

Case No.	UK Legislation	EU legislation	Upcoming legislation	Future Legislation	Average score
1	to a very great extent (5)	to a very great extent	to a very great extent	to a very great extent	5.00
2	to a very great extent	to a very great extent	to a very great extent	to a very great extent	5.00
3	to a very great extent (5)	to a very great extent (5)	to a great extent (4)	to a moderate extent (3)	4.25
4	to a very great extent	to a very great extent	to a very great extent	to a very great extent	5.00
5	to a very great extent	to a very great extent	to a very great extent	to a great extent	4.75
6	to a small extent (2)	to a small extent	to a small extent	not at all (1)	1.75

STAGE 3: KRUSKAL WALLIS TESTS OF DIFFERENCE

Test Statistics[a,b]

	average score for legislation drivers
Chi-Square	19.470
df	4
Asymp. Sig.	.001

a. Kruskal Wallis Test

b. Grouping Variable: sector type

Significant difference (p=0.01) in the legislative external driver scale variable between one or more sectoral groups

Ranks

	sector type	N	Mean Rank
average score for legislation drivers	public	41	89.20
	construction, utilities, transport/logistics	23	81.41
	service & retail/wholesale	22	41.57
	mixed service/manufacturing	16	67.91
	manufacturing	44	72.74
	Total	146	

Highest mean rank score= greatest intensity of legislative pressure

Lowest legislative pressure in service/ wholesale and retail group (mean rank score =41.6

Highest legislative pressure in Public sector (mean rank score = 89.2)

APPENDIX 12: PUBLISHED PAPERS FROM PHD RESEARCH

Corporate Social Responsibility and Environmental Management
Corp. Soc. Responsib. Environ. Mgmt 11, 71–84 (2004)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/csr.055

MANAGING THE INTERFACE BETWEEN SUPPLIERS AND ORGANIZATIONS FOR ENVIRONMENTAL RESPONSIBILITY – AN EXPLORATION OF CURRENT PRACTICES IN THE UK

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This paper examines the supplier management activities undertaken by a sample of 149 UK based organizations, with particular focus on the role of supplier assessment and supplier coaching, education or mentoring. This study identifies that larger, higher risk organizations are beginning to reach out to their suppliers, primarily through assessment and evaluation, and to a lesser extent through supplier education, mentoring or coaching. Copyright © 2004 John Wiley & Sons, Ltd and ERP Environment.

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INTRODUCTION

In order to address their environmental responsibilities organizations are increasingly focusing upon their supply chains and in particular the environmental behaviour and responsibilities of their suppliers. This paper examines the empirical findings of a survey of operational practices of green supply chain management in 149 UK organizations. The paper begins by discussing the interface between suppliers and organizations and the manner in which a variety of 'green supply chain' practices occur. In particular the paper discusses the two key supplier interface arenas – that of supplier assessment/evaluation and that of supplier education and monitoring. The paper then presents the empirical findings of the green supply chain survey undertaken in association with the Chartered Institute of Purchasing and Supply.

METHODOLOGY OF RESEARCH STUDY

The findings reported in this paper form part of a wider examination of environmental supply chain management amongst members of the Chartered Institute of Purchasing and Supply (CIPS). An environmental supply chain questionnaire was distributed to 1457 organizations, addressed to a CIPS member at senior management level, in a broad range of sectors and company sizes. The questionnaire was examined by a focus group of members of the CIPS environmental panel and then piloted amongst a sample of CIPS companies to assess the structure, length and appropriateness of the questions used (with 10 pilot responses received from a range of sectors). In September 2002 CIPS members were informed that this survey was taking place via an article in the members' magazine. Questionnaires were distributed in September 2002 with a second call sent via email in December.

Of the total number of questionnaires distributed (1457) there were 149 usable responses, a 10.2% response rate (in addition 139 questionnaires were either undeliverable, or gave reasons why they did not answer). This response rate is relatively low – however, in terms of total number of responses it still provides a large number of organizational responses. Other survey based research studies of one or more aspects of green supply chain management compare favourably in terms of absolute numbers. Autry *et al.* (2001) reports on results from 71 organizations in the USA, the influential study by Carter and Carter (1998) had 125 responses and the Klassen–Whybark (1999) US study had 83 responses. The Murphy *et al.* (1994, 1995, 1996) studies had 133 responses and an additional 24 from the EU sample and 31 Canadian responses. The Rao (2002) study in S.E. Asia reported a 10% response rate amongst 'leading edge' 14001 certified companies. In the Zsidisin–Hendrick (1998) study a 12.5% response rate was reported for the UK sample, as part of a combined overall response rate between Germany, the USA and the UK of 14.3%.

This study comprises cases from a wide range of primarily UK based organizations of different sizes, sectors, levels of commitment and specific constraints. Andersen (1991) states that the 'most different cases' as opposed to the 'most similar cases' should be examined when developing theoretical propositions. This study examined mainly medium and large enterprises, with organizations of fewer than 10 employees being excluded from the sample selected from the CIPS database. The main reason for this was that these very small companies are represented less in the type of database used in this study, and are unlikely to have dedicated purchasing/logistics personnel. Other studies that used similar kinds of database (Murphy *et al.*, 1994, 1995, 1996; Carter and Carter, 1998; Carter *et al.*, 1998, 2000; Min and Galle, 1997) all reported that the databases used were biased towards larger organizations.

Non-response bias was examined in the data collected using the guidelines established by Armstrong and Overton (1977), who suggest the responses of early and late respondents should be examined, as late respondents are more likely to respond to survey questions in the same way as non-respondents than those that reply earlier. Autry *et al.* (2001) also adopt the Armstrong–Overton (1977) guidelines for assessing non-response bias and compared responses with the final quartile of respondents (with the those responses provided by the first three quartiles). In this study questionnaires were forwarded to the author in batches, and placed in order of arrival of the batches. Since an exact cut-off point could not be established the final quartile of responses, as with Autry *et al.* (2001), were compared with the first three-quarters of the sample of respondents order to assess non-response bias. The potentially anonymous nature of the questionnaire research instrument and the UK Data Protection Act in place at the CIPS meant that the researcher could not mail a 'slimmed' down questionnaire to non-respondents, nor could the researcher phone non-respondents. *T*-tests were conducted on 103 variables between the early (first three quartiles) and late respondents (final quartile) and only two were found to have significant differences at the $p < 0.05$ level; neither was significant at the $p < 0.01$ level. Therefore, it could arguably be assumed that non-response bias has not been found in the sample of data with reference to the guidelines established by Armstrong and Overton (1977).

GREENING THE SUPPLY CHAIN THROUGH SUPPLIER MANAGEMENT AND PURCHASING

Green supply chain literature suggests that purchasing can be viewed as way of greening the procurement function of an organization but also as a way of influencing others in a supply chain. A Touche Ross survey in 1991 (reported by Charter, 1992) saw 60% of the UK's largest companies requesting ecological information from suppliers. Unlike a purchase by an individual, who is 'free' to decide which product they wish to buy and from whom, the situation is a little more complex when we discuss organizational purchasing or 'industrial' consumption. Some organizations are required to buy only from certain suppliers, or can only buy from an approved product list. Issues of quality, price and continuity of supply are paramount. However, organizations are beginning to use environmental criteria as part of the process of selecting a product or a supplier. Lamming and Hampson (1996) review the methods of vendor assessment using environmental criteria. The use of supplier questionnaires has been used by organizations such as B&Q, and Lamming and Hampson (1996) note the main areas of concern included in such questionnaires as regulatory compliance; environmental effects and performance measurement; existing environmental management procedures and commitment to managerial and process improvement, regardless of what is supplied. Lamming and Hampson (1996) further note that the assessment process might seem to disadvantage suppliers. However, if assessment is approached in a collaborative manner it may be possible to provide benefits to suppliers through demonstration of best practice, investment in best available technology and attracting new customers in new markets when standards requested by the customer are recognized. This collaborative aspect is an interesting aspect of the green purchasing debate with the role of supplier education, mentoring or coaching perhaps being critical in determining whether green supply initiatives actually ripple down the supply chain. Morton (1996) notes the recommendations from BiE (1993) for a 'partnering' approach to environmental management or co-operation strategies whereby two-way dialogue between suppliers and customers can be mutually beneficial. King (1996) notes examples of packaging solutions developed in the retail industry by dialogue between customers and suppliers. Hutchinson (unpublished MBA thesis) believes that environmental issues have provided catalysts for reviewing customer–supplier relationships, leading away from the traditional adversarial relationship towards one of partnership.

Khoo and Spedding (2001) state that companies are facing increasing pressure to balance marketing performance with environmental issues. Such environmental issues are creating challenges for businesses, and Khoo and Spedding draw attention to the work of Cox (1999), who identifies that companies have created networks of suppliers to build common understanding and learn about waste reduction and operational efficiencies in the delivery of existing products and services. Partnership sourcing is defined by Partnership Sourcing Ltd (1991:2 in Paul, 1996) as a situation whereby the 'customer and supplier develop such a close long term relationships that the two must work together as partners. It is not philanthropy: the aim is to secure the best possible commercial advantage. The principle is that teamwork is better than combat. If the end-customer is to be best served then the parties to a deal must work together and both must win. Partnership sourcing works because both parties have an interest in each other's successes'.

However, when this definition of partnership is examined it becomes it very clear that such partnerships are two-way processes, mutually win–win scenarios, rather than the imposition of requirements through guidelines or supplier criteria. As Paul (1996) notes, the critical success factors in partnerships in the supply chain are amount and freedom of information flow, teamwork of committed parties on both sides and attention to detail during the matching, vetting and courtship stages of partnering. Another aspect of green supply chain partnerships is the coaching and mentoring role that can be taken by 'larger' organizations, industry bodies or green business groups. Berger *et al.* (2001) discuss the case of a project on 'environmental partnering action for SMEs in supply chains' in industrial South Wales. An environmental supply chain management network has been established to bring together large manufacturing firms in the region to exchange information and share best practices on environmental supply chain management. There is also a collaboration programme with large companies within a mentoring programme to bring about a partnership approach in working together with lower tier suppliers. Gascoigne (2002) details 'Project Acorn', which aims to help organizations improve environmental performance. The project involves a five level approach to implementing an environmental management system, currently being piloted. The project aims to bring together large organizations with their suppliers to develop mutually beneficially environmental management programmes. The supplier–mentor relationship is identified as a key element of the possible success of Project Acorn.

Baylis *et al.* (1998) discuss the implications of green purchasing within SMEs and note it may be possible for SMEs to make internal environmental management changes but that few large companies will entertain making changes to accommodate the requirements of SME customers or suppliers, a view echoed by Hill (1997), who notes that the balance of power between suppliers and customers is such that suppliers and SMEs are less persuasive in the greener purchasing process. The location of a firm within a supply chain is also important, complex and rarely linear. Baylis *et al.* (1998) note that the assumption that an SME is below a larger firm in the supply chain is in fact an erroneous one. This has implications for the success of the 'trickle down' effect of green supply chain management as part of a 'green multiplier' effect. As Paul (1996) notes, by taking care during the selection and development stages of partnering, duplication of effort with other potential suppliers is wasteful and such a partnering approach therefore usually exists alongside a reduced supplier base. Taylor and Welford (1993) identified a reduction in the supplier bases of IBM from 4000 to 2700.

From the perspective of supplier management within a programme of green supply chain management an organization may undertake a range of activities as detailed below.

- Seek information on environmental aspects of policies, processes and systems from suppliers (Hill, 1997; Green *et al.*, 1998).
- Impose specific requirements upon suppliers (BiE and CIPS, 1997; Hill, 1997).
- Address their own accreditation to an environmental management standard by assessing a supplier's environmental performance (Clayton and Rotheroe, 1997; Baylis *et al.*, 1998).
- Cease to purchase from suppliers who fail to meet criteria set (Baylis *et al.*, 1998; Knight, 1995; Clayton and Rotheroe, 1997).
- Cease to purchase from suppliers who fail to provide information requested (Baylis *et al.*, 1998).
- Undertake a 'coaching' programme to share experiences and best practice with their suppliers (BiE, 1993; BiE and CIPS, 1997).

The following sections of this paper examine different aspects of supplier management amongst the 149 organizations surveyed in the study detailed earlier. The particular focus of this paper is 'how' the supplier/customer interface is managed in the organizations surveyed and whether any statistically significant associations can be made between 'actions' and a range of classifying criteria.

GENERAL OVERVIEW OF THE SURVEY RESPONDENTS

As illustrated in Table 1, the majority of the respondents are medium or large enterprises (94.6%). The original screening of the sample was designed to exclude those companies with fewer than 10 employees. A small number of micro/small organizations were included in the final sample, reflecting those organizations that did not provide information on size in the CIPS database. 49.7% of the respondents are organizations with over 1000 employees.

The relative influence of a variety of internal and external factors driving organizational responses to environmental issues was examined elsewhere (Holt and Kockelbergh, 2003) and is not detailed in full in this paper. However, the influence of legislation, image and risk (perceived and actual) appear to be the most influential factors. Correspondingly pressure from the insurance industry, pressure groups and employees are amongst the least influential. The respondents in the sample overwhelmingly believe that it is important to their organization to manage environmental issues, with 84.6% of respondents stating that this is extremely important or important. All organizations that responded believe that importance of environmental issues will increase ($n = 130$) or stay the same ($n = 18$), with no organization believing that the importance of environmental issues will decrease over time. There is a slight observable difference between the importance placed on environmental and ethical issues, with environmental issues perceived to be of slightly more importance (mean =1.78) than ethical issues (mean = 2.06), on a scale that ranges from very important (1) to not important at all (5).

GENERAL SUPPLIER–CUSTOMER CHARACTERISTICS

As illustrated in Table 2, all the organizations have a minimum of 10 suppliers, with over

Table 1. Sectoral, size and turnover distribution of respondents

Type of sector (n = 145)	Valid percentage	Employees (N = 147)	Valid percentage	Size class (n = 149)	Valid percentage
Public	30.3	1–9	2.7	Small (0–49)	5.4
Service	10.3	10–49	2.7	medium (50–249)	32.2
Mix service & manufacturing	9.7	50–99	8.8	large (over 250)	62.4
Retail/wholesale	4.1	100–249	15.6	Turnover (N = 105)	
Utilities	5.5	250–499	12.9	Minimum	£1.95 million
Construction	6.9	500–999	7.5	Maximum	£22 billion*
Manufacturing	31.0	1000+	49.7		
Transport and logistics	2.1	Total	100.0		

* Figures reported here are from the organization as a whole, rather than just the UK subsidiary. Nine companies reported turnovers in excess of £0.5 billion per year and included two banks, a multinational chemical company and a multinational telecommunications company. The largest turnover was from a global telecommunications and mobile technology firm.

Table 2. Numbers of customers ($n = 143$) and suppliers ($n = 145$) of the organizations surveyed in relation to the size of the organization

Number of employees	1	2–4	5–9	10–49	50–99	100–199	200–299	300–499	500–999	1000–2499	2500–4999	Over 5000	General public
Number of suppliers (%)				5.6	9.0	4.9	8.3	6.3	20.1	14.6	11.1	20.1	
Number of customers (%)	2.1	2.8	0.7	12.6	7.7	4.9	4.2	9.1	2.8	6.3	2.8	16.1	28.0

Table 3. The extent to which environmental issues affect decisions made in purchasing and logistics

	Frequency	Valid percentag
Environmental issues are considered above other factors	1	0.7
Environmental issues are given equal consideration with other factors	49	33.1
Secondary consideration after other more important factors	73	49.3
Not considered during purchasing or as part of logistics	19	12.8
Env. issues are not considered by the organization at all	6	4.1
Total	148	100
Missing	1	
Total	149	

20% of the sample having more than 5000 suppliers. The number of customers an organization has is even more diverse, with almost 5% of the sample having four or fewer customers, so the presumption is that these organizations are heavily dependent upon these customers. 16.1% of the sample have over 5000 customers, and again in this case it could be presumed that these companies are reasonably independent of any influence from their customers. 28% of the sample also state that they supply goods and service to the general public, and this high figure is perhaps linked to the number of public organizations in the sample.

As illustrated in Table 3, only one organization (a large biological and biotechnological company) identifies environmental issues as being considered above the other key decision making criteria in purchasing and logistics. 32.9% of organizations consider environmental issues as part of a package of decision-making criteria. However, 18.8% do not consider environmental issues during purchasing, logistics or even at all. 49% of organizations consider environmental issues but only as a secondary consideration.

Green Supply Chain Operational Practices Associated with Supplier Management and Outreach Activities

Table 4 details the most frequent operational practices associated with supplier management and outreach activities amongst the organizations surveyed. The most frequent activities are identified as an informal assessment of suppliers' environmental and ethical performance, followed by a communication of environmental/ethical criteria to suppliers. Over 40% of the respondents have received environmental guidance from their own suppliers and almost 50% are bound by EU purchasing directives (which have possible implications as to how influential environmental criteria can be in purchasing decisions). Formal policies on green purchasing are used less (with only 28% of respondents using formal green purchasing guidelines). Outreach activities are also amongst the less frequent actions undertaken, with only 15% of organizations running workshops for suppliers and 12.5% actually visiting suppliers to assist them to improve environmental performance.

Table 4. Operational practices associated with outreach activities (valid %)

	Yes	Intend to in next 12 month	No/don't
We consider ethical and human rights/welfare issues informally in our purchasing decisions	64.71	9.56	25.74
We assess the environmental acceptability and performance of our suppliers informally in our assessment criteria	56.82	7.58	35.61
We communicate to our suppliers our environmental and/or ethical criteria for goods and services we buy	53.74	13.61	32.65
We expect our suppliers to take back the packaging or pallet systems they use to supply goods to us	52.71	11.63	35.66
We ask suppliers to use recyclable pallet systems when they deliver supplies to us	50.43	6.96	42.61
We have green purchasing or logistics guidelines that recommend the environment is considered	48.23	14.89	36.88
We are bound by external purchasing directives (e.g. the EC Procurement Directive or Franchise agreements)	48.20	3.60	48.20
The organization is part of an industry specific partnership that shares good practice/lobbying	41.91	3.68	54.41
We have received environmental guidance from our own customers	39.58		60.42
We assess the environmental acceptability and performance of our suppliers in a formal process	38.19	17.36	44.44
The organization is part of a supply chain initiative that is involved in active dialogue with suppliers and/or stakeholders	38.13	10.07	51.80
We educate our suppliers through written material	33.79	11.72	54.48
The organization is part of a general 'green' network that shares environmental or ethical good practice or information	31.39	5.84	62.77
We consider ethical and human rights/welfare issues formally in our purchasing decisions	29.50	17.99	52.52
We have a formal policy on green procurement/purchasing	28.08	24.66	47.26
We set environmental criteria that suppliers must meet	27.89	25.17	46.94
We run workshops/seminars to educate our suppliers	15.28	11.81	72.92
We have been the recipient of educational workshops and visits by our customers to educate us on what environmental improvements can be made	15.11	1.44	83.45
The organization is part of an group that sources products and suppliers (such as the Ethical Trading Initiative)	13.43	6.72	79.85
We (or someone on our behalf) goes into our suppliers' organizations to help them improve environmental performance	12.50	9.72	77.78

ASSESSING SUPPLIERS

The relationship between a range of classifying criteria and whether an organization asks suppliers about their environmental performance is examined in Table 5.[1] There appear to be statistically significant associations between number of employees, size classification (based on DTI classes), importance of environmental issues to the customer organization,

[1] The variable associated with whether a supplier is asked about environmental performance is a dichotomous variable. De Vaus (2002) states that as a general principle a dichotomous variable can be treated as an interval variable and used to assess interval with ordinal data. Bryman and Cramer (2001) recommend that contingency tables using tau-c can be used to assess ordinal and interval relationships, chi squared with phi can be used to assess two dichotomous variables and chi squared can be used to assess nominal with ordinal data.

Table 5. Whether organizations asked suppliers about their environmental performance and relationship to a range of organizational characteristics – tests for significant associations

Organizational characteristics	Nature of variable	Type of test used	*N*	Value	df	Asymp. std error	Approximate *T*	Approximate sigma	Asymp. sigma (two sided)
Sector	nominal	Pearson chi squared	145	11.26	7				0.128
Type of market (e.g. B2b)	nominal	Pearson chi squared	132	2.51	2				0.285
Type of structure (e.g. overseas group, UK independent, UK group)	nominal	Pearson chi squared	118	3.56	3				0.313
Organizational structure (e.g. UK HQ, UK subsidiary etc)	nominal	Pearson chi squared	131	9.96	4				0.041
Amount of control organization has over decision making regarding environmental issues	nominal	Pearson chi squared	127	1.68	3	0.64			0.642
Number of employees	ordinal	Kendall's tau-c	143				4.08	**0.000**	
Size of company (DTI classifications)	ordinal	Kendall's tau-c	143	0.35		0.07	4.71	**0.000**	
Importance of managing environmental issues	ordinal	Kendall's tau-c	144	−0.32		0.08	−3.83	**0.000**	
Possible environmental impact	ordinal	Kendall's tau-c	133	0.21		0.09	2.25	**0.024**	
Possible environmental risk	ordinal	Kendall's tau-c	136	0.25		0.09	2.82	**0.005**	
Number of customers	ordinal	Kendall's tau-c	139	0.20		0.09	2.14	**0.032**	
Number of suppliers	ordinal	Kendall's tau-c	140	0.29		0.09	3.12	**0.002**	
Level of critical dependency of organization on particular suppliers	ordinal	Kendall's tau-c	136	−0.05		0.09	−0.53	0.595	
Whether controlled by UK based organization	dichotomous	Phi	131	−0.01				0.879	
Environmental attitude of organization	Ordinal	Kendall's tau-c	139	0.564		0.07184	7.85	**0.00**	

attitudinal classification of the organization[2] and the perceived level of environmental risk and environmental impact the customer organization identifies with their own operations.

[1]Organizations were classed as progressive, moderate or conservative (after Murphy *et al.*, 1996) based on four attitudinal questions (which included the importance of managing environmental issues).

The data in Table 5 seems to support the hypothesis that larger, higher risk organizations are reaching out beyond their own supply chains to influence suppliers. Overall 59.7% of the organizations surveyed ask suppliers about their environmental performance, but 37.1% of these organizations use differing criteria depending on the individual supplier. Appendix 1 details the reasons given as to why different standards are used. There appear to be common themes emerging as to why different criteria are used which relate to specific impact of the goods/services, country of origin, level of risk and how important the supplier/products are.

REJECTING SUPPLIERS AND BEING REJECTED

Three organizations state that they have been rejected as a supplier for environmental reasons, 114 state that that they have not and the remainder did not answer this question. As illustrated in Table 6, 35.6% of the respondents state that they have rejected a supplier on environmental grounds, whilst a further 43.7% state that they would not reject a supplier based on their environmental performance. 20.7% of the respondents stated that they would not reject a supplier on environmental grounds and 62 organizations did not answer.

A Kruskal–Wallis non-parametric test identified no statistically significant association between sector, size, possible environmental risk and environmental impact of the organizations and whether they would reject a supplier on environmental grounds. However, the importance of environmental issues was significant at $p = 0.043$.

THE 'GREEN MULTIPLIER' EFFECT

Twenty-one organizations state that their environmental requirements have influenced their suppliers into setting their own environmental criteria for second tier suppliers and below. Fourteen organizations identify specific examples of their influence resulting in their own supplier subsequently influencing other suppliers in the supply chain. One company identifies how the elimination of possible contamination resulted in enforced checks at their supplier and subsequent cleaning regime at the second tier supplier. Another organization identifies how second tier suppliers embarked on ISO14000 and another supplier appointed environmental staff in order to be included in a tender. Two organizations identify second tier suppliers addressing packaging issues. Another organization identifies that suppliers have asked for advice on how environmental improvements can be made. One organization demands that their corporate printers meet their strict criteria and that these suppliers have subsequently asked their paper and ink suppliers to follow suit.

Fifty-nine organizations state that they have been required to make changes to their goods

Table 6. Percentage of organizations that would or have rejected a supplier on environmental grounds

Would you, or have you ever rejected a supplier who failed to meet *your* environmental criteria	Frequency	Percent	Valid percentage
yes we have	31	20.8	35.6
no we would not	18	12.1	20.7
yes we would	38	25.5	43.7
Total	87	58.4	100.0
Missing	62	41.6	
Total	149	100.0	

and/or services by an external party for environmental reasons, which comprises 39.6% of all the organizations in the survey. Examples of these changes are presented in Appendix 2.

USE OF ENVIRONMENT CRITERIA AND STANDARDS

As illustrated in Table 7, the most popular supplier assessment criterion identified by respondents is that the supplier must not have been identified publicly as having a poor environmental or ethical performance. 40% of organizations identify the presence of an environmental policy amongst suppliers as essential, and a further 57% of organizations would like suppliers to have an environmental policy. Yet accreditation to an environmental management standard gains the lowest response in terms of actual operational practices undertaken by respondents and only approximately 8% of respondents state that it is essential that their suppliers accredit to ISO14001, EMAS or similar standards. The seven organizations that identify accreditation to an environmental management standard as essential are all large companies, but from a range of sectors.

CONCLUSION

The data presented in this paper identifies some interesting themes for future investigation. In particular, later analysis will focus on detailed statistical assessment of the factors that appear to be influencing whether suppliers are assessed on the basis of environmental performance (risk, impact, attitude and size all appear to be influential). In addition, a more detailed assessment of the multiplier effect is needed. If green supply chain management is to cascade environmentalism through the industrial ecosystem, then investigation of why certain suppliers have influenced their own suppliers further down the supply chain is essential to establish how the green multiplier effect is working in some supply chains and not others. Only 21 of the 149 organizations stated that they felt that their own environmental stance had influenced their suppliers. Moreover, 18 organizations stated that they would not reject a supplier even if they failed to meet their own environmental criteria. The effectiveness of environmental supply chain initiatives must be questioned if customers are prepared to set environmental criteria, but not enforce this with deselection.

Table 7. Types of environmental criterion used in supplier assessment

	Essential %	Would like %	Not considered %
That we have no adverse knowledge of, or see recent media coverage, of poor environmental/ethical performance of supplier (n = 85)	54.12	38.82	7.06
That the supplier has an environmental policy (n = 90)	40.00	56.67	3.33
That the supplier meets the environmental criteria we as a company have designed (n = 90)	36.67	50.00	13.33
That the supplier meets the ethical/fair trade standards we as a company use (n = 87)	33.33	42.53	24.14
That our suppliers meet our environmental criteria within a set time period (n = 87)	33.33	51.72	14.94
That our suppliers have considered resource reduction, reuse and recycling in the design of products we use (n = 89)	12.36	75.28	12.36
That the supplier has accredited to an environmental management standard such as ISO14001 or EMAS (n = 90)	7.78	78.89	13.33

A detailed investigation of the types of environmental criterion used to assess suppliers is also needed. The use of an environmental policy as a measure of assessment is an essential or preferred criterion of almost 97% of respondents. Yet only approximately 8% stated that accreditation to an environmental management standard was essential. The stronger the environmental attitude of the organization, the more 'tougher' environmental assessment measures appear to be used. Therefore further work is needed on how the attitudinal stance of the organization appears to be translated into more proactive operational activity.

There is a need to identify whether patterns emerge between the types of supplier assessment measure used and organizational criteria that could assist suppliers in anticipating customer requirements for environmental improvements. Another perhaps important area for future research is how the 'balance of power' between customers and suppliers may influence supply chain initiatives. In this study the dependency on customers, and how influential customers are upon the supplier organization, appears not to be significant, but more detailed analysis of this relationship between 'channel power' and environmental operational activity is needed.

The data presented in this paper does seem to suggest that organizations are beginning to consider environmental issues in supplier assessment and evaluation, although in the main at a fairly low level. Yet outreach activities that involve coaching or mentoring suppliers are still extremely low. This lack of assistance for suppliers is especially disturbing for the SME sector, which would traditionally need more 'hands-on' guidance, and may eventually be rejected as suppliers for failing to confirm to environmental standards they do not understand or require assistance to achieve.

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APPENDIX 1. REASONS GIVEN BY ORGANIZATIONS AS TO WHY COMMON ENVIRONMENTAL CRITERIA ARE NOT USED FOR ALL SUPPLIERS (DIRECT QUOTES FROM ORGANIZATIONS SURVEYED)

All component and direct consumables suppliers will be required to achieve 15014001 by 2004.
Chemical suppliers are examined more closely.
Criteria are defined for major suppliers and high-risk services only.
Criteria depend on the nature of their operations and the goods or services required from them.
Criteria will very according to products being purchased and perceived environmental impacts.
Depending on type of industry the supplier is in.
Depends on how environmentally sensitive the work undertaken is.
Depends on the country of origin.
Depends on the nature of good/service being purchased.
Depends on the products or services being provided, which are classified according to risk/impact.
Depends on type of product supplied – all suppliers asked if have ISO14001, but in some sectors there are no suppliers with this.
Depends on type of supply.
Depends on work/services involved.
Depending on goods/services required.
Different criteria apply to chemical suppliers.
Different criteria apply to different types of supplier.

Aspects such as waste may have specific criteria.
Different criteria for energy only.
Impact of services/good.
Manufacture in 20 countries with R&D in 5, depends on standard within country.
Some additional areas are considered that are industry specific.
Some suppliers are sole traders carrying out research and are considered low impact.
Our customers specify some suppliers.
Some work carried out has high environmental risk so higher standards set.
There is a core set of criteria, then supplier specific are developed dependent on industry they operate in.
We ask if they have a policy and ISO14001 but if they say no we do not stop using them.
We ask suppliers what their environmental policies are and to identify hazards with products they supply.
We use a framework, which is adapted to suit wide and diverse range of products/services.

APPENDIX 2. EXAMPLES OF CHANGES THE ORGANIZATIONS SURVEYED HAD BEEN REQUIRED TO MAKE AT THE REQUEST OF AN EXTERNAL PARTY FOR ENVIRONMENTAL REASONS (DIRECT QUOTES FROM ORGANIZATIONS SURVEYED)

Change of heating system – oil to gas.
Changes to packaging legislation in Germany meant our distributor there requested we change.
Combustion resilient foam in upholstery, asbestos removal or sealing, COSHH regulations.
Compliance and improvement to ISO14001.
Constant supervision of new legislation. Improving plant to meet future emission levels.
Dangerous Preparations Directive enforcement in 2002.
End user required FSC timber and/or MDF or reassurances about forest management and sustainability.
EU legislation.
If a product is shown to have a positive health and safety impact we are required to explore suitability.
Incineration of fumes from production.
Legislation.
Likely to have happened – no specific examples.
Local authority – emissions from powder painting process to be reduced and monitored.
M&S change from PVC to PP or APET.
Mainly on design issues.
Major customer is ***** County Council – require products that are friendlier to environment.
Medical legislation.
Monitoring system evolve with legislative change.
NHS estates/department of health. NHS purchasing and supply agency.
Not to burn chlorine based products etc.
Peer pressure to improve.
Planning applications for UK radio base stations either refused or amended sometimes.
Pressure group campaigns.
Public pressure to lobby council re: extending landfill license.
Recycle instead of buying from quarry.
Recycling logos on packaging.
Reduce amount of packaging and use returnable packaging.
Replacement of raw materials in products. Changes in emergency response procedures.
Scandinavian customers require environmental statement for products. Others require packaging data.
The organization has been contractually obliged to comply with certain environmental procedures.
To meet requirements of ISO14001 environmental standard.
We are constantly scrutinised by the Environment Agency.
When tendering for business with The Body Shop.
When we gained ISO14001 approval.

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BIOGRAPHY

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APPENDIX 13: STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN PROGRESSIVES, MODERATES AND CONSERVATIVES

Table 13.1: Significant differences between progressives, moderates and conservatives in terms of their response to drivers of environmental management [1]

Internal and External Drivers	Scheffe post hoc test		Mean Diff	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	**Classification of attitude**	**Classification of attitude**				**Lower**	**Upper**
influence of UK's current environmental legislation	Conservative	Progressive	-0.85	0.23	0.00	-1.40	-0.29
EU's current environmental legislation	Conservative	Progressive	-0.82	0.26	0.01	-1.48	-0.17
Forthcoming environmental legislation	Conservative	Moderate	-0.82	0.24	0.00	-1.42	-0.22
	Moderate	Progressive	-0.64	0.18	0.00	-1.09	-0.18
	Progressive	Conservative	1.45	0.24	0.00	0.87	2.04
Possible environmental legislation in the future	Conservative	Moderate	-0.72	0.27	0.04	-1.39	-0.04
	Moderate	Progressive	-0.70	0.21	0.00	-1.22	-0.18
	Progressive	Conservative	1.42	0.27	0.00	0.77	2.08
Requirements of organisations that you supply to	Conservative	Moderate	-1.23	0.32	0.00	-2.01	-0.44
	Progressive	Conservative	1.63	0.31	0.00	0.87	2.39
Encouragement from organisations that you supply goods and services to	Conservative	Moderate	-0.89	0.28	0.01	-1.59	-0.19
	Progressive	Conservative	1.29	0.27	0.00	0.62	1.97
	Conservative	Progressive	-1.15	0.45	0.04	-2.28	-0.03
Influence of your own suppliers that provide goods and services to your organisation	Conservative	Moderate	-0.90	0.24	0.00	-1.49	-0.31
	Moderate	Progressive	-0.46	0.18	0.05	-0.90	-0.01
	Progressive	Conservative	1.36	0.23	0.00	0.78	1.93
Public opinion/ societal expectation	Conservative	Progressive	-0.87	0.27	0.01	-1.54	-0.21

[1]Only 19 of the possible 22 are presented as the remaining 3 show no statistically significant differences

Internal and External Drivers	Scheffe post hoc test		Mean Diff	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	**Classification of attitude**	**Classification of attitude**				**Lower**	**Upper**
	Progressive	Moderate	0.57	0.21	0.03	0.05	1.10
Pressure from green action groups	Conservative	Progressive	-1.25	0.26	0.00	-1.90	-0.60
	Moderate	Progressive	-0.95	0.21	0.00	-1.47	-0.43
	Progressive	Conservative	1.25	0.26	0.00	0.60	1.90
Maintaining or presenting an environmentally or socially responsible image	Conservative	Progressive	-1.15	0.22	0.00	-1.70	-0.59
	Moderate	Progressive	-0.63	0.18	0.00	-1.07	-0.19
Pressure from shareholders or investors	Conservative	Progressive	-1.16	0.33	0.00	-1.98	-0.34
	Moderate	Progressive	-0.69	0.26	0.03	-1.34	-0.05
Pressure from employees	Conservative	Progressive	-0.73	0.22	0.00	-1.26	-0.19
	Moderate	Progressive	-0.46	0.17	0.03	-0.89	-0.04
The CEO (or equivalent) commitment to environmental improvement	Conservative	Moderate	-0.89	0.28	0.01	-1.58	-0.20
	Moderate	Progressive	-0.59	0.22	0.03	-1.13	-0.06
	Progressive	Conservative	1.49	0.27	0.00	0.81	2.16
Culture of the organisation promotes environmental responsibility	Conservative	Moderate	-0.73	0.24	0.01	-1.32	-0.14
	Moderate	Progressive	-0.89	0.18	0.00	-1.35	-0.44
	Progressive	Conservative	1.62	0.23	0.00	1.05	2.20
Provides operational cost savings	Moderate	Progressive	-0.89	0.24	0.00	-1.48	-0.29
Provides new market opportunities	Conservative	Moderate	-0.88	0.31	0.02	-1.65	-0.11
	Progressive	Conservative	1.35	0.31	0.00	0.60	2.11
To perform better than our competitors or equivalent institutions	Conservative	Moderate	-0.87	0.34	0.04	-1.70	-0.03
	Progressive	Conservative	1.14	0.33	0.00	0.33	1.95
In order to reduce the health and safety risk associated with our goods, services or operational practices	Conservative	Moderate	-0.67	0.28	0.06	-1.35	0.02
	Progressive	Conservative	-0.92	0.27	0.00	-1.59	-0.25
In order to reduce the public's perceived risk associated with our company	Conservative	Progressive	-0.91	0.29	0.01	-1.62	-0.20

Table 13.2: Specific operational practices and environmental attitudinal typlogy

Specific Green Supply Chain Management Operational; Practices	Classification of attitude	N	Mean Rank	Chi-Square	df	Asymp. Sig.	Specific Green Supply Chain Management Operational; Practices	Classification of attitude	N	Mean Rank	Chi-Square	df	Asymp. Sig.
We communicate to our suppliers our environmental and/or ethical criteria for goods and services we buy	Conservative	24	105.6	29.30	2	**0.000**	We have a formal policy on green procurement/ purchasing	Conservative	25	92.16	15.65	2	**0.000**
	Moderate	53	70.99					Moderate	53	74.75			
	Progressive	64	58.00					Progressive	62	58.14			
We run workshops/seminars to educate our suppliers	Conservative	24	86.08	10.01	2	**0.007**	We have a formal policy on green logistics/transport	Conservative	25	84.80	14.64	2	0.001
	Moderate	53	70.31					Moderate	49	74.10			
	Progressive	61	62.27					Progressive	61	56.21			
We educate our suppliers through written material	Conservative	24	98.71	21.82	2	**0.000**	We have a green purchasing or logistics guidelines that recommend the environment is considered	Conservative	25	90.32	16.45	2	**0.000**
	Moderate	53	70.86					Moderate	51	70.64			
	Progressive	62	58.15					Progressive	59	56.26			
We (or someone on our behalf) goes into our suppliers' organisations to help them improve environmental performance	Conservative	24	84.50	14.73	2	**0.001**	We are bound by external purchasing directives (e.g. the EC Procurement Directive or Franchise agreements)	Conservative	25	66.20	0.11	2	0.945
	Moderate	52	74.04					Moderate	51	66.88			
	Progressive	62	59.89					Progressive	58	68.60			
We have received environmental guidance from our own customers	Conservative	24	86.00	10.08	2	**0.006**	We consider ethical and human rights/ welfare issues informally in our purchasing decisions	Conservative	25	79.06	8.84	2	**0.012**
	Moderate	52	72.29					Moderate	48	69.56			
	Progressive	62	60.77					Progressive	58	57.42			
We have been the recipient of educational workshops and visits by our customers to educate us on what environmental improvements can be made	Conservative	24	75.19	10.04	2	**0.007**	We consider ethical and human rights/ welfare issues formally in our purchasing decisions	Conservative	25	84.50	16.20	2	**0.000**
	Moderate	52	71.72					Moderate	52	74.23			
	Progressive	57	59.25					Progressive	57	53.90			
Paper recycling in offices is standard practice	Conservative	25	83.64	8.33	2	0.016	We consider environmental matters generally in our transport decisions	Conservative	22	83.34	12.20	2	**0.009**
	Moderate	51	73.40					Moderate	46	64.46			
	Progressive	65	64.25					Progressive	58	55.22			
We recycle toner cartridges in the offices	Conservative	25	75.44	1.08	2	0.582	We have invested in vehicles that are designed to have reduced environmental impacts	Conservative	20	65.22	12.90	2	**0.001**
	Moderate	52	69.43					Moderate	42	58.79			
	Progressive	64	70.54					Progressive	43	41.66			
Energy efficiency measures are adopted for lighting and heating	Conservative	24	85.00	6.66	2	0.036	We plan the routes of our vehicles in order to reduce environmental impacts	Conservative	19	63.37	11.14	2	0.264
	Moderate	53	68.78					Moderate	37	49.58			
	Progressive	65	68.73					Progressive	40	40.44			

Specific Green Supply Chain Management Operational; Practices	Classification of attitude	N	Mean Rank	Chi-Square	df	Asymp. Sig.	Specific Green Supply Chain Management Operational; Practices	Classification of attitude	N	Mean Rank	Chi-Square	df	Asymp. Sig.
We actively manage the disposal of packaging wastes	Conservative	25	94.40	17.70	2	**0.000**	We have energy efficiency systems in operation in our warehouses	Conservative	15	63.73	15.78	2	0.264
	Moderate	53	69.45					Moderate	35	45.21			
	Progressive	63	63.02					Progressive	38	36.25			
We actively manage the disposal of all solid wastes in the organisation	Conservative	19	78.21	6.18	2	**0.046**	We ask suppliers to use recyclable pallet systems when they deliver supplies to us	Conservative	18	71.47	9.47	2	0.174
	Moderate	50	61.07					Moderate	40	59.16			
	Progressive	59	62.99					Progressive	53	48.36			
We are required by law to control the disposal of some of our wastes (e.g. medical waste)	Conservative	18	67.33	3.46	2	0.177	We expect our suppliers to take back their packaging or pallet systems they use to supply goods to us	Conservative	22	84.98	15.14	2	0.054
	Moderate	45	62.04					Moderate	42	63.29			
	Progressive	56	56.00					Progressive	60	53.71			
We have accredited to an Environmental Management Standard such as ISO14001 or EMAS	Conservative	20	94.00	35.39	2	**0.000**	The organisation is part of an industry specific partnership that shares good practice / lobbying	Conservative	22	72.32	2.66	2	**0.002**
	Moderate	49	74.72					Moderate	50	68.35			
	Progressive	59	46.01					Progressive	58	60.46			
We assess the environmental acceptability and performance of our suppliers informally in our assessment criteria	Conservative	25	77.54	6.84	2	**0.033**	The organisation is part of an group that sources products and suppliers (such as the Ethical Trading Initiative)	Conservative	22	72.23	2.66	2	**0.002**
	Moderate	50	62.96					Moderate	49	65.83			
	Progressive	51	57.15					Progressive	58	61.56			
We assess the environmental acceptability and performance of our suppliers in a formal process	Conservative	25	102.2	30.39	2	**0.000**	The organisation is part of a general 'green' network that shares environmental or ethical good practice or information	Conservative	22	76.93	3.50	2	**0.004**
	Moderate	53	73.17					Moderate	51	66.05			
	Progressive	61	54.05					Progressive	58	61.81			
We set environmental criteria that suppliers must meet	Conservative	25	101.8	25.43	2	**0.000**	The organisation is part of a supply chain initiative that is involved in active dialogue with suppliers and/or stakeholders	Conservative	22	80.93	5.85	2	**0.000**
	Moderate	53	73.11					Moderate	51	68.74			
	Progressive	63	56.99					Progressive	60	60.42			

APPENDIX 14 : CORRELATION MATRIX OF POSSIBLE RELATIONSHIPS IN GREEN SUPPLY CHAIN MODEL

Variables	Short Code		Leg	Sup Ch	Soc	Comp	Int Dr	Ext Sum	Env Att	Sup Obst	Inter Obst	SECM	GRLP	IEOM	GL	SA	IN	Total GSCM
		Pearson corr.		0.33	0.65	0.28	0.60	0.78	0.52	0.04	-0.23	0.37	0.50	0.40	0.27	0.40	0.40	0.58
		Sig. (2-tailed)	.	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.65	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Legislation	Leg	N	146	142	146	140	141	139	142	140	140	143	145	146	138	145	138	146
		Pearson corr.	0.33		0.41	0.45	0.39	0.70	0.51	-0.06	-0.27	0.35	0.28	0.22	0.33	0.40	0.10	0.40
	Sup	Sig. (2-tailed)	**0.00**	.	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.49	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.26	**0.00**
Supply Chain	Ch	N	142		143	140	139	139	139	139	138	140	142	143	135	142	135	143
		Pearson corr.	0.65	0.41		0.43	0.70	0.85	0.42	0.04	-0.11	0.28	0.43	0.21	0.26	0.33	0.25	0.43
		Sig. (2-tailed)	**0.00**	**0.00**	.	**0.00**	**0.00**	**0.00**	**0.00**	0.64	0.21	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**
Societal	Soc	N	146	143		141	142	139	143	141	141	144	146	147	139	146	138	147
		Pearson corr.	0.28	0.45	0.43		0.40	0.70	0.33	0.00	-0.18	0.14	0.13	0.14	0.24	0.22	0.11	0.24
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	.	**0.00**	**0.00**	**0.00**	1.00	0.03*	0.09	0.14	0.09	**0.01**	**0.01**	0.20	**0.00**
Competitive	Comp	N	140	140	141		138	139	137	137	137	139	140	141	134	140	134	141
		Pearson corr.	0.60	0.39	0.70	0.40		0.70	0.51	0.03	-0.29	0.32	0.35	0.30	0.22	0.29	0.27	0.46
Internal		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.00**	.	**0.00**	**0.00**	0.71	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**
drivers	Int Dr	N	141	139	142	138		136	138	136	136	141	141	142	135	142	135	142
summary		Pearson corr.	0.78	0.70	0.85	0.70	0.70		0.59	0.04	-0.25	0.38	0.45	0.32	0.35	0.45	0.27	0.55
external	Ext	Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	.	**0.00**	0.69	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
drivers	sum	N	139	139	139	139	136		135	135	135	137	138	139	132	138	133	139
		Pearson corr.	0.52	0.51	0.42	0.33	0.51	0.59		0.10	-0.42	0.48	0.48	0.48	0.41	0.49	0.27	0.64
Environmental	Env	Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	.	0.25	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Attitude	Att	N	142	139	143	137	138	135		137	137	140	142	143	136	142	134	143
		Pearson corr.	0.04	-0.06	0.04	0.00	0.03	0.04	0.10		0.46	-0.05	0.06	-0.04	-0.03	-0.08	-0.01	-0.06
Supplier	Sup	Sig. (2-tailed)	0.65	0.49	0.64	1.00	0.71	0.69	0.25	.	**0.00**	0.52	0.51	0.66	0.70	0.32	0.93	0.48
Obstacles	Obst	N	140	139	141	137	136	135	137	143	142	141	143	143	135	142	137	143
Internal	Inter	Pearson corr.	-0.23	-0.27	-0.11	-0.18	-0.29	-0.25	-0.42	0.46		-0.18	-0.06	-0.27	-0.14	-0.30	-0.12	-0.26

Variables	Short Code		Leg	Sup Ch	Soc	Comp	Int Dr	Ext Sum	Env Att	Sup Obst	Inter Obst	SECM	GRLP	IEOM	GL	SA	IN	Total GSCM
Obstacles	Obst	Sig. (2-tailed)	**0.01**	**0.00**	0.21	0.03*	**0.00**	**0.00**	**0.00**	**0.00**	.	0.03*	0.51	**0.00**	0.11	**0.00**	0.17	**0.00**
		N	140	138	141	137	136	135	137	142	143	141	143	143	135	142	136	143
Supplier education, coaching and mentoring		Pearson corr.	0.37	0.35	0.28	0.14	0.32	0.38	0.48	-0.05	-0.18		0.49	0.33	0.48	0.49	0.39	0.80
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	0.09	**0.00**	**0.00**	**0.00**	0.52	0.03*	.	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	SECM	N	143	140	144	139	141	137	140	141	141	146	145	146	139	146	140	146
Green Procurement and Logistic Policy		Pearson corr.	0.50	0.28	0.43	0.13	0.35	0.45	0.48	0.06	-0.06	0.49		0.20	0.34	0.48	0.36	0.70
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	0.14	**0.00**	**0.00**	**0.00**	0.51	0.51	**0.00**		0.02*	**0.00**	**0.00**	**0.00**	**0.00**
	GPLP	N	145	142	146	140	141	138	142	143	143	145	148	148	140	147	140	148
Internal Environmental Operations Management		Pearson corr.	0.40	0.22	0.21	0.14	0.30	0.32	0.48	-0.04	-0.27	0.33	0.20		0.35	0.35	0.17	0.63
		Sig. (2-tailed)	**0.00**	**0.01**	**0.01**	0.09	**0.00**	**0.00**	**0.00**	0.66	**0.00**	**0.00**	0.02*		**0.00**	**0.00**	0.04*	**0.00**
	IEOM	N	146	143	147	141	142	139	143	143	143	146	148		141	148	140	149
Green Logistics		Pearson corr.	0.27	0.33	0.26	0.24	0.22	0.35	0.41	-0.03	-0.14	0.48	0.34	0.35		0.36	0.10	0.67
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	0.70	0.11	**0.00**	**0.00**	**0.00**		**0.00**	0.27	**0.00**
	GL	N	138	135	139	134	135	132	136	135	135	139	140	141		140	133	141
Supplier Assessment		Pearson corr.	0.40	0.40	0.33	0.22	0.29	0.45	0.49	-0.08	-0.30	0.49	0.48	0.35	0.36		0.23	0.66
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	0.32	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.01**	**0.00**
	SA	N	145	142	146	140	142	138	142	142	142	146	147	148	140		140	148
Industrial Networks		Pearson corr.	0.40	0.10	0.25	0.11	0.27	0.27	0.27	-0.01	-0.12	0.39	0.36	0.17	0.10	0.23	1.00	0.54
		Sig. (2-tailed)	**0.00**	0.26	**0.00**	0.20	**0.00**	**0.00**	**0.00**	0.93	0.17	**0.00**	**0.00**	0.04*	0.27	**0.01**		**0.00**
	IN	N	138	135	138	134	135	133	134	137	136	140	140	140	133	140		140
Total operational activity	Total GSCM	Pearson corr.	0.58	0.40	0.43	0.24	0.46	0.55	0.64	-0.06	-0.26	0.80	0.70	0.63	0.67	0.66	0.54	
		Sig. (2-tailed)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.48	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
		N	146	143	147	141	142	139	143	143	143	146	148	149	141	148	140	

* Correlation is significant at the 0.05 level (2-tailed)   Correlation is significant at the **0.01** level (2-tailed).

APPENDIX 15: HIERARCHICAL REGRESSION STATISTICS FOR ADVANCED GREEN SUPPLY CHAIN MODEL

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	-10.44	5.26		-1.99	**0.05**	-20.85	-0.04					
Percentage score for environmental attitude	0.71	0.07	0.66	10.14	**0.00**	0.57	0.84	0.66	0.66	0.66	1.00	1.00
(Constant)	-18.18	5.45		-3.34	**0.00**	-28.96	-7.41					
Percentage score for environmental attitude	0.55	0.08	0.52	6.95	**0.00**	0.39	0.70	0.66	0.52	0.43	0.71	1.41
average score for legislation drivers	5.16	1.40	0.27	3.68	**0.00**	2.38	7.94	0.55	0.31	0.23	0.71	1.41
(Constant)	-18.65	5.56		-3.35	**0.00**	-29.65	-7.65					
Percentage score for environmental attitude	0.54	0.08	0.51	6.54	**0.00**	0.38	0.70	0.66	0.50	0.41	0.66	1.53
average score for legislation drivers	4.83	1.58	0.26	3.06	**0.00**	1.70	7.96	0.55	0.26	0.19	0.56	1.78
average score internal composite[1]	0.73	1.61	0.04	0.46	0.65	-2.45	3.91	0.45	0.04	0.03	0.59	1.70
(Constant)	-18.79	5.59		-3.36	0.00	-29.84	-7.73					
Percentage score for environmental attitude	0.54	0.08	0.51	6.53	0.00	0.38	0.70	0.66	0.50	0.41	0.65	1.53
average score for legislation drivers	4.52	1.75	0.24	2.59	0.01	1.06	7.97	0.55	0.22	0.16	0.46	2.16
average score internal composite	0.33	1.87	0.02	0.17	0.86	-3.37	4.02	0.45	0.02	0.01	0.44	2.29
average score for societal drivers	0.85	1.98	0.04	0.43	0.67	-3.07	4.77	0.43	0.04	0.03	0.41	2.46

[1] No longer statistically significant – next level included for comparison. Statistics on supply chain and competitive not included

APPENDIX 16: PUBLICATIONS FROM THIS RESEARCH STUDY

Copies available upon request

Reports

Holt, D. and Kockelbergh, C (2003) *Managing Environmental Issues through Purchasing and Supply Initial Report*, Middlesex University and The Chartered Institute of Purchasing and Supply.

Forthcoming Refereed Journal Articles

Holt, D. (2004) 'Managing the interface between suppliers and organisations for environmental responsibility – an exploration of current practices in the UK', *Corporate Social Responsibility and Environmental Management* 11:2, 71-84

Refereed Conference Papers

Holt, D. (2003) 'Greening the supply chain- benchmarking organisational attitude and performance', *Decision Sciences Conference Proceedings*, Washington, November 22nd-25th

Other Conference Papers

Holt, D (2004) 'Green supply: exploring buyer supplier relationships in the Public sector', *Greening of Industry Conference*, 7-10 November, Hong Kong

Holt, D and Ghobadian, A (2004) 'Predicting green supply chain management practices in the manufacturing sector,' *EUROMA Conference*, Fortainbleu, France, June

Holt, D and Ghobadian, A (2003) 'Greening the Supply Chain –critical factors driving operational activity', *Greening of Industry Conference*, San Francisco, 12-15th October (online)

Holt, D and Kockelbergh, C (2003) 'Green Supply Chain Management in the UK – An analysis of current practices', *IPSERA Conference Proceedings*, April, Hungary, 677-689

Holt, D and Ghobadian, A (2002) 'Green supply chain management - the emerging research agenda', *10th International Conference of the Greening of Industry Network*, Corporate Social Responsibility - Governance for Sustainability, June 23-26, Goteborg, Sweden.